new scientist

12 July 1973
Vol 59 No 854

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This One
UJBL-5KS-3FAC

PUBLISHED WEEKLY

Annual subscription: £8·50
USA and Canada (airfreight) $29·25
Back numbers (cash with order) 35p
including postage from IPC Magazines Ltd,
66-69 Great Queen Street, London WC2E 5DD
Registered at The Post Office as a newspaper
and printed in England
2nd class postage paid at Jamaica NY, 11431
© IPC Magazines Ltd, 1973

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GAS. SOME VITAL STATISTICS.

TOTAL GAS SALES 1967/68: 4,222 million therms. 1972/73: 10,000 million therms (est).	DIRECT SALES OF NATURAL GAS. 1967/68: 13·4 million therms. 1972/73: 7,500 million therms (est).
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GAS AVAILABLE IN PEAK WEEK. 1967/68: 150 million therms. 1972/73: 303 million therms (est).	SALES OF CENTRAL HEATING EQUIPMENT. 1967/68: 283,000 units. 1972/73: 510,000 units (est).

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BRITISH GAS Our Vital Industry

Comment

Nanny in the air: Indemats wash whitest

The main lines of the Clean Air Council's report on the confidentiality of air pollution data, officially published earlier this week were revealed in New Scientist over two months ago (vol 58, p 138). As I then wrote, a government Working Party under Admiral P. G. Sharp has decided not to ask for the repeal of the secrecy clauses in our air pollution legislation. Instead, the public is to be protected from the shock of raw, indigestible air pollution data by the establishment of scores of committees representing industry, local authorities and the public, which will interpret and edit the facts into a more comprehensible form. There is, however, one respect in which my earlier Comment was incorrect. I understood then that Sharp wanted these local committees (inelegantly christened Indemats, from *in*dustrial *em*issions to the *at*mosphere) to be based on the 53 new county councils. In fact, Sharp proposes that they follow the new district councils. So, in the unlikely event of such a multitude of municipal nannies meeting with unqualified enthusiasm, we may see 402 little Indemats interpreting pollution data from Berwick-on-Tweed to Penzance. Quite incorrectly, the Sharp report claims that these proposals have the support of the press and the conservation movement.

In one respect the Indemat scheme, at present a consultative document and likely to be embodied in the portmanteau Environment Protection Bill due to reach Parliament late this year, will represent a substantial improvement on present practice. Where a district council is unhappy about the control exercised over a local industry by the Alkali Inspectorate, it will be able to establish an Indemat with powers to extract from both industry and inspectorate detailed data on permitted emissions, actual emissions and ambient air pollution levels, and will be able to publish these figures together with its comments. Powers of this sort would, for instance, have greatly simplified the current bitter dispute between Northfleet UDC, the Alkali Inspectorate, and Associated Portland Cement Manufacturers.

However, other aspects of the Indemat scheme are less auspicious. First, where a district council establishes an Indemat (and there will be no compulsion to do so), its members are to be nominated in equal parts by the council and local industry. These will then nominate a further group to represent the public, an arrangement which would give the town halls and boardrooms complete power to exclude inconvenient critics.

The second major flaw in the Sharp proposals is the total absence of any requirement that the pollution data—as opposed to an Indemat's comments on it—be made available to the press and public. Although Indemats would meet in public unless they deliberately went into closed session (another loophole subject to abuse), it would be easy for the members to base their open discussions on secret reports—a procedure already commonly used in local government.

Third, and perhaps most important, the Sharp report specifically opposes the repeal of two notorious secrecy clauses (section 26 of the Clean Air Act 1956 and section 287(5) of the Public Health Act 1936); it fails altogether to mention the similar legal gag in section 12 of the Alkali Act 1906 which the Alkali Inspectorate has used to justify its legendary tight lips. "We content ourselves," say Sharp and his colleagues, "with recommending that these sections should not be allowed to hinder or inhibit the operation of the (Indemat) system." Unfortunately, clerks to local councils may well take a different view, and use these unrepealed clauses as justification for continued secrecy.

Eldon Griffiths, the DoE Minister in charge of pollution, spoke eloquently to journalists this week of his wish to spare them the ordeal of reading vast chunks of raw pollution data without any accompanying interpretation. In my experience, a more common hazard is chunks of interpretation without any data. The widespread and not always unfounded suspicion of conservation groups in Britain is that alkali and local public health inspectors are involved in private agreements with industry in which the public interest is inadequately represented. The deplorable practice of agreeing secret emission limits, and of keeping secret the results of joint emission monitoring schemes, only encourages these suspicions. The Indemat proposals do not require (though they do permit) the publication of these secret data, and until such a reform is introduced, public confidence is unlikely to be restored.

Admiral Sharp claims that his proposals will "get rid of confidentiality". Eldon Griffiths says "there is a public demand that confidentiality be swept aside". In spite of these brave claims, the Indemat scheme does nothing of the sort. Unless it is drastically strengthened before being embodied in legislation, it will merely entrench the "Nanny knows best" mentality.

Jon Tinker

Testing the world's patience

France's imminent nuclear tests offer a straight example of a case where the people should listen to the (disinterested) body of scientific opinion, rather than to their own politicians. As we go to press the French government has ordered all shipping to steer clear of Muroroa Atoll in French Polynesia, which, with neighbouring Fangataufa Atoll, will be the site of these high-altitude atmospheric tests. It has also issued a White Paper intended to allay public fears and calm international indignation. It seems strange as we approach the 10th anniversary of the Partial Test Ban Treaty (signed by 106 nations, but not by France or China, on 5 August, 1963) to have to reiterate all the old arguments. For the simple fact is that no "safe" threshold level of radioactive fallout exists, a conclusion with which all sane workers in the field have ultimately concurred—after prolonged debate. Yet here is the French government blithely stating that their forthcoming tests pose no threat to the environment. Risks "are so minimal that they can only be considered negligible." More rudely, they attribute anxiety and stress in Australia and New Zealand (and presumably other concerned countries) partly to these nations' own governments' propaganda. All of this is a direct flouting of United Nations concern, the urging of the Stockholm conference on the human environment to stop tests, and the injunction granted against the tests to Australia and New Zealand by the International Court of Justice.

One would hardly think a mere force de frappe worth-while grounds to incur the world's displeasure. But true to Gaulliste intransigence, M Pompidou persists. Should we read into this pig-headedness a fear of withdrawal of American forces from Europe, and an irrepressible desire for an equitable bilateral settlement should an Anglo-French nuclear detente ensue? Such a policy, by creating a third nuclear force, is in any case tantamount to a form of nuclear proliferation totally contrary to the spirit of a deterrent balance. A nuclear deterrent could keep the peace only so long as it involved two superpowers. Britain should not countenance such madness for one moment.

Strategics apart, though, the French government's apologia for the tests includes some strange arguments. The southern hemisphere's winter winds, it claims, will satisfactorily disperse the fallout. But there is every indication that a proportion of the debris, at least, is carried into the stratosphere and distributed on a global scale. That makes nonsense of the French plea that Pitcairn Island, the nearest human habitation to the test site, is a good 600 miles away (unless you stipulate, erroneously, a "safe" threshold which would be met by the diluted fallout).

What is particularly distasteful, as with the earlier British and American tests, is that France should carry out its dirty work in someone else's back yard. But, says the White Paper, note that neither the Australian nor New Zealand governments objected during those earlier tests. Perhaps, however, it is just possible that we have all matured politically a little since then, quite apart from having now a much better appreciation of the radiation hazards involved.

For the record France has now conducted 43 tests, 13 of which were underground with US cooperation; the UK 21; the US 539; the USSR 254; and the Chinese 12. Many of these, of course, were underground. But the nuclear threat has not lessened with the years, however blasé some of us may have become. What the world needs is a complete cessation of all kinds of testing and a sincere move towards nuclear disarmament—5 August, 1973, as the United Nations has pleaded, would have been an appropriate landmark for achieving this goal. *Peter Stubbs*

Transport mystification

Express buses for London, a government report promising increased restraint of cars in cities, and MPs fighting for British Rail—all seemingly indicate a new enlightened attitude toward transport. A closer look suggests an effort to satisfy the public with superficial gestures and without the hard effort required to rethink the basic question of transport.

There is little point in announcing new bus routes for London when London Transport has just cut back underground services because it cannot obtain staff, because they, in turn, cannot afford to live in London. Perhaps London Transport, like bus and tram operators in Hong Kong and elsewhere, will be forced to provide flats for its staff. But surely this problem must be solved first?

The Urban Transport Planning paper issued last week (Cmnd 5366), despite its lip service on car restrictions, clearly indicates that the government does not understand. "The rapid growth in the ownership of private cars is bringing personal transport within reach of a majority of people," the report begins. Yet official forecasts of car ownership show that even by the year 2000, over half the population will not have optional use of a car, according to a new book, Personal Mobility and Transport Policy, published last week by Political and Economic Planning. At present, two-thirds of all adults, plus the 27 per cent of the population under driving age, lack optional access to a car. Indeed, half the households in Britain do not even own a car.

The government paper is actually "observations" on the Expenditure Committee report on urban transport. That report recommended that "the assumptions made and the methods used in the transportation studies should be made more comprehensible to the layman." The government reply is that assumptions "need to be made more intelligible", but that "methods used require specialist knowledge and are not readily or helpfully expressed in simple terms." In other words, the government appears to be saying, "We will tell you the options, but we will mystify you with science jargon so that you cannot challenge our choice among the options." The significance of this was made clear last Sunday by the Sunday Times, which reported that a "scare campaign" is to be waged by the government to secure backing for the new London airport, and that the road from London to the airport will require the building of the inner London ringway, supposedly killed by environmental protests.

This is part of a generally ambivalent approach to satisfy everyone by talking a lot, mystifying as much as possible, and giving as little as possible. The government must face the fact that the real transport problem is that of moving people and goods as efficiently as possible with the minimum of environmental damage—not moving rich adults at the expense of the young, the old, and the poor.

Joseph Hanlon

Another select committee rebuff

The government has thrown out almost all the recommendations for the future of further and higher education in Britain put forward six months ago by the education and the arts subcommittee of the Commons Select Committee on Expenditure. These include proposals for a higher education commission on the lines of an extended University Grants Committee, a Manpower Council, and a National Careers Advisory Service. The government interpreted the committee's recommendations in the narrowest, literal sense, and paid scrupulous attention to detail in rejecting them. The technique has, of course, been used before. Last year, a report of the Select Committee on Science and Technology, which included a proposal for a minister of science, was rejected equally resoundingly, and Mr Airey Neave, committee chairman, felt obliged to call the then leader of the House and Lord Privy Seal, Lord Jellicoe, to explain the government's action before the committee.

Why should these select committees make recommendations which are so unacceptable to government? One explanation is that they are creatures of Parliament, isolated not only from government, but also from those sectors of the community in which they profess an interest. They deliberate, and then propose new advisory boards, councils, Ministers, departments even, all of which is irrelevant to the internal logic of education or science. They ask, in fact, for rejection.

To become effective, these committees must lose their naiveté. Their members must be well-informed, and must have access to authoritative advice. For groups of Members of Parliament to work on a topic for six months or more, only to have their conclusions rejected peremptorily, is at worst a waste of public time and money.

Alan Cane

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Galaxies expose the cracks in new cosmological models

A yawning credibility gap in the new cosmological models recently discussed by Fred Hoyle and J. V. Narlikar has been exposed by Jeno Barnothy of Illinois and Beatrice Tinsley of the University of Texas. They claim that the new models lead to drastic discrepancies with the observations of faraway galaxies. Unless the stars evolved in a fundamentally different manner long ago there is no way of rescuing the novel theories (Astrophysical Journal, vol 182, p 343).

In papers published over the last three years Hoyle and Narlikar took an excursion through models of the universe in which the mass of a particle depends on a mass field created by all other particles. An intriguing discovery during their explorations was the variation of the factor linking particle mass to the mass field. In terms of Newtonian physics they found that the gravitational constant G should decrease strongly with time. This would have many unusual consequences for astrophysics and geophysics: the Sun would get cooler and the Earth expand as they aged. In an address last year to the Royal Astronomical Society, and in a recent book, Fred Hoyle has stated that the theory "does not seem to lead to a conflict with available data".

Barnothy and Tinsley deal a shattering blow to this confident statement in a consideration of the effects of variations in G on the luminosities of stars in distant galaxies. According to the Hoyle-Narlikar theory the stars were more luminous in past cosmic epochs when G was larger. To put it another way, stars in distant galaxies, which are viewed as they were long ago, should look brighter than similar stars in the Milky Way.

If G has varied, then spiral galaxies should have been much brighter in the past, say Barnothy and Tinsley. But the number of bright spirals now observed deep in the universe is too small to sustain this conclusion. The only way round the difficulty is to suppose that the birth-rate of stars rises sharply with time, an improbable state of affairs.

The situation is just as bad with elliptical galaxies. These are dominated by stars of about one solar mass, and ought to appear bluer with increasing distance if G is decreasing. Again this conclusion is totally at variance with thoroughly reliable observations. For one last-ditch stand Barnothy and Tinsley suggest a recalculation of stellar structure, to see if fundamental changes occur at very large values of G. Even so, it seems implausible that these could paper over the cracks in the theory.

Sweet proteins will help researchers

What makes a taste sweet? At one time —just about a year ago in fact—one would have replied vaguely that for a substance to generate a sensation of sweetness it had to be a small molecule that could interact in some sort of specific way with taste receptor cells hidden in crevices in the tongue. Exactly what this interaction was though was far from clear: do the sweet molecules react with components on the outer surface of the cell membrane, do they combine with molecules buried inside the receptor cell membrane, or do they pass right through and have their effect inside the cell? The recent discovery that two proteins—large molecules by any standards —could taste sweet adds weight to the intuitive belief that the sweet reaction is a surface phenomenon.

In a recent Science (vol 181, p 32) Robert Cagan of the University of Pennsylvania suggests that the two proteins —called monellin and thaumatin, both of which come from the fruit of different tropical plants—should be termed chemostimulatory proteins because of their direct sensory effect. These proteins, which are at least 30 000 times sweeter than sucrose, could both turn out to be extremely useful tools in research into the taste mechanism. A third protein, called miracullin, also from the fruit of a tropical plant, is dubbed by Cagan a "taste-modifying protein". Although it doesn't taste sweet itself, miracullin can convert the sour taste of an acid into sweetness. The arrival of these three unusual proteins on the taste research scene should cause quite a stir.

Protein chemists find that miracullin, monellin and thaumatin all have roughly similar amino-acid patterns, a fact that could be important in their sweetness. Although they are not especially large proteins (miracullin has about 400 amino-acids, monellin 100 and thaumatin 200) they are almost certainly too big to pass easily through the taste cell membrane. The importance of specific tertiary shape in the two chemistimulatory proteins is demonstrated by the loss of sweetness when the molecules are denatured. A surface reaction involving a well exposed receptor site on the taste cell's outer membrane therefore seems to be operating in sweetness.

Soviets manufacture the Northern Lights

Soviet geophysicists recently successfully induced artificial aurorae in the ionosphere as part of their guided space programme. The idea of injecting electrons into the ionosphere in order to stimulate natural processes and obtain a better understanding of what causes them is quite new. It requires sophisticated techniques including a controlled rocket and a powerful electron gun injector. The advantage of the method is that the exact electron energy is known for the light effect produced.

The Soviet experiment (called Zarnitsa from the Russian word for dawn), used a meteorological rocket with an electron accelerator on board. The pulsed electron injection along the lines of force of the Earth's magnetic field started at a height of about 100 kilometres and lasted several minutes. The research team took over 300 pictures of the induced polar lights.

According to Professor Vladimir Migulin, director of the Institute of Terrestrial Magnetism in Moscow, the Zarnitsa experiment was a rehearsal for the Soviet French Arax experiment, where a French rocket, Eridan, will lift a Soviet electron accelerator, plus other instruments, from Kerguelen Island in the south of the Indian Ocean. Apart from simulating the aurorae, they may also use electron injection to study other charged particle effects in the Earth's magnetic field.

Cooperating at a distance in immunity

Cells cooperate in immunity—that much seems certain. But we still don't know how they do it. With research activity at its present pitch, however, it shouldn't be too long before we have the answers. And two papers in a recent Nature New Biology go some way to piecing together the solution.

Basically the immune defences come in two parts: the humoral response (antibodies) and the cell mediated response. Both phases of the defences involve the white blood cells known as lymphocytes, but the populations are distinct. So-called B-lymphocytes are designed to manufacture antibodies. The cell mediated response is performed by T-lymphocytes, so-called because at an early stage in their life they are processed by the thymus gland. As well as mediating a direct cellular attack (against certain microorganisms, organ transplants and incipient cancer cells) T-cells are also involved in helping B-cells initiate their antibody production.

The problems to which the two Nature articles address themselves are first, do T- and B-cells have to be in direct physical contact for the cooperation to be effective, or do the T-cells simply send out a "message" that is picked up by the antibody-producing B-cells? And second, are there two distinct populations of T-cells, one of which mediates the cellular immune attack while the other helps the B-cells turn on the antibody syntheses?

In their first paper (vol 244, p 20) Herbert Yu and Julius Gordon, both of McGill University, Montreal, present what they believe is strong evidence in favour of a soluble message that passes between T- and B-cells. They find that when they incubate mouse lymphoid cells with foreign antigens (sheep red blood cells, SRBC) they can prepare a cell-free supernatant that can stimulate mouse B-cells to produce specific anti-SRBC antibodies. Yu and Gordon cannot say very much yet about the nature of the message. What they do know is that it is labile at 56°C and cannot be dialysed—it is therefore probably a protein of some sort.

Yu and Gordon also use mouse lymphoid cells and SRBC in their experiments on the identity of helper T-cells. Very simply, they inject SRBC into the foot pad of a mouse at a concentration designed to induce a cell mediated response. When the cellular reaction is at its height (three days after the injection) Yu and Gordon find they cannot induce significant antibody formation in lymphoid cells challenged in vitro with SRBC. It seems that in generating a cell-mediated immune response the lymphoid system becomes drained (at least temporarily) of T-cells capable of cooperating with B-cells to synthesise antibody. Yu and Gordon suggest in their paper (vol 244, p 21) that the cells mediating the cellular response and the cells that cooperate with B-cells share a common precursor and that the two separate functions are expressed at different stages of the cell's differentiation.

Are 'extinct' volcanoes the most dangerous?

Judging from the great heights attained by certain marine volcanoes, those on land appear to be kept within bounds by some unknown mechanism. Could it be that once their cones reach a critical size, the only way they can continue to evolve is by blasting off their tops cataclysmically, or foundering, to form large calderas? After analysing the sizes of nearly 200 active volcanoes, that is the proposal with which P. W. Francis and B. M. Abbott of the Open University have come up (Nature, vol 244, p 22).

The Hawaiian volcano Mauna Loa rises, they point out, 9144 m above the sea bed. All of this height is due to a single volcanic pile. Why, then are land volcanoes nowhere near as high?

Francis and Abbott find that few land volcanoes rise more than 3500 m above their bases. They suggest that this may be because they then go on to develop large calderas. They show from the diameter that most major calderas were indeed derived from volcanoes probably 3000 to 4000 m high. They have little to offer by way of explanation except that possibly there may be a limit to the height to which the magma column inside the volcano will rise.

If their deduction is right, they say, it might help to account for a number of volcanic anomalies such as why calderas are common on the Japanese part of the circum-Pacific belt, but absent in the Andes despite many cones 3000 m high. Here may be one potential danger area for caldera formation. Any cone which has reached that height, they say, could be ripe for such development. The very violent "Plinian" eruptions which begot the calderas of Vesuvius in AD79 and Katmai in 1912, both occurred in volcanoes previously regarded as extinct. They conclude: "The next major caldera-forming eruption may well involve therefore a volcano now generally considered 'extinct'". The only consolation is that the largest calderas seem to have formed more by inward collapse than explosion.

Slow viruses are accused of causing schizophrenia

Is schizophrenia an infectious disease? That seems a bizarre question, because schizophrenia does not look like an infection. But it has been asked before, in the early part of this century, with respect to bacteria. Now it has been raised again, this time with respect to slow viruses. And the arguments, presented by E. Fuller Torrey of the National Institute of Mental Health, Maryland, and Michael Peterson of the Langley Porter Neuropsychiatric Institute, San Francisco, are intriguing.

Several viruses have now come to light that cause symptoms only months or years after infection; some of these affect the nervous system. Indeed, kuru, an ultimately fatal disease of the central nervous system (CNS), which is spread among certain New Guinea natives by cannibalism, was the first disease of man proved to be caused by such a "slow" virus.

Torrey and Peterson admit that all known slow virus diseases of the CNS whether in man or animals, produce changes visible under the microscope. No such changes are known in schizophrenia. But viruses—such as the Epstein-Barr virus—are now being elicited from tissues that were apparently virus-free. Cytomegalovirus (CMV) can be carried by adults apparently without causing symptoms, though CMV damages the CNS of foetuses or newborns. In general, say the American authors in their account in Lancet (vol 2, 1973, p 22) "viruses may damage cells by various specific immunological responses in much more subtle ways than the direct damage previously shown".

Torrey and Peterson point out that schizophrenia occurs in several forms, and there is no general consensus on the classification of sub-types. Furthermore several CNS diseases, including suspected slow-virus diseases such as multiple sclerosis, may produce schizophrenic symptoms. The Americans agree that the resemblance between schizophrenia and some diseases known to be carried by viruses does not by itself mean that schizophrenia is viral; several non-viral states, such as bromide intoxication or porphyria, may also resemble schizophrenia. But, they say, "schizophrenia [may be] merely a clinical final common pathway for various pathological agents, with viruses, alone or synergistically, being one such agent." And, "different sub-types of schizophrenia could be related to different causative agents or, alternatively, to the different parts of the cortex affected."

Some of the changes that occur in some cases of schizophrenia—including changes in serum enzymes and other proteins, and some immunological oddities—might be explained if some cases of schizophrenia were viral. Also, reports that schizophrenia is seasonal (a disproportionate number of schizophrenics are born in the first quarter of the year), and that it may be commoner in countries with high standards of living, could fit in with the infection hypothesis. Polio, for example, was commoner in countries with high standards of hygiene, because young children can form antibodies against it, and older people cannot, and children are more likely to be exposed where hygiene is poor.

Twin studies suggest schizophrenia may have a genetic origin: but a common aetiological agent, such as a virus, which might change the foetuses in utero, could explain the present data equally. It seems that schizophrenic are more likely to produce malformed children.

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What does the cell switch switch on?

Cells grow or they differentiate (they become specialised). Generally the two processes are mutually exclusive and the choice between them for any given cell must be governed by a "simple" switch mechanism. Exactly what mediates this switch—to growth or to differentiation—has been a matter of speculation for some time, but the primary contender emerging seems to be that favourite molecule of 1970s biochemists—cyclic AMP.

Important parameters determining rate of growth include membrane transport, protein and RNA synthesis, and protein degradation. These characteristics fluctuate in a coordinated way with fluctuations in growth rate; together they are known as the pleiotypic programme. In cells grown in culture lacking enough nutrients (starved serum for example) the pleiotypic programme is switched off—the cells don't grow. Add fresh serum, however, and growth resumes: the pleiotypic switch is "on". Insulin also switches on the programme even in starved serum. So what is behind the switch?

Gordon Tomkins and his team at the University of California, San Francisco, have been asking this question and they reasoned that if, as they suspect, cAMP is the mediator, one should see the level of this chemical fluctuate as a cell goes through periods of growth and differentiation. When they compared normally growing fibroblast cells with virus-transformed fibroblasts (whose growth switch seems permanently in the "on" position) they found low levels of cAMP. In fibroblasts that are not growing, however, the cAMP level is elevated. If cAMP is the mediator it ought to be possible to turn a cell on and off simply by adding the chemical to the culture medium.

Tomkins and his colleagues tried this and, sure enough, found that exogenous cAMP turned off the membrane transport processes just as one would have predicted. But it had no effect on the intracellular events (protein synthesis for example). When they boosted the intracellular cAMP level (by adding a prostaglandin), protein and RNA synthesis were shut off and protein degradation increased, all part of the coordinated pleiotypic response.

It does look therefore as if cAMP is the pleiotypic control mediator; but are there two phases, one at the membrane and the other inside the cell? It may be, however, that externally added cAMP simply cannot penetrate the membrane in an experimental situation. Important questions still outstanding are what activates the mediator (some say that insulin is a good candidate) and how does the switch get stuck "on" in cancer cells? (PNAS, vol 70, p 1432).

Sloth is in muscle as well as in mind

In a zoological extension of the effort to reduce personality to biochemistry, two Californian biologists have been examining the muscle biochemistry of sloths, in the hope of discovering what makes the sloth slow (Journal of Comparative Neurology, vol 149, p 259). James Toole and Theodore Bullock have clearly been arrested by the distinctive character of their subjects for some time; and this is hardly surprising since the sloth seems to be a furry phenomenon rivalled for evolutionary quirks only by the duck-billed platypus.

Toole and Bullock catalogue several examples. For one thing, mammals are supposed to maintain a constant temperature—but sloths do so consistently only when pregnant. Moreover, they can stop breathing without doing their hearts and brains an injury; and not only is it impossible to make them jump, they do not even produce the universal righting reflex when dropped, but flop inert upon the ground.

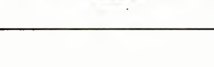
This general sluggishness is reflected in their internal processes as well: a sloth's dinner takes an average of two weeks to travel from one end of him to the other. To return to nerve and muscle, which are the real preoccupation of Toole and Bullock, the sloth's muscles are arranged in a characteristically idiosyncratic way.

Most of us have a nice balance of flexor and extensor muscles: sloths have pathetic extensors but extremely powerful flexors. What is more, many muscles which are extensor in most mammals act as flexors in the sloth; so although he is relatively lightly muscled by comparison with the average mammal, he can perform the remarkable feat of suspending himself at right angles to gravity for minutes at a time.

His wiring is such that muscle contractions tend to spread, and may go so far as the limb opposite that which first started to contract: so when a sloth is stimulated, its net response is to seize up. And when he does move, of course, it is very, very slowly.

Why is the sloth so slow? Are his muscles simply incapable of rapid contraction? Toole and Bullock conclude from their investigations that muscular slowness contributes, but by no means completely explains the laggardlyness of the animals. They took six two-toed sloths (Choloepus) and four three-toed sloths (Bradypus), and looked at the levels of the activity of their muscle ATPase, the enzyme that breaks down the molecule supplying the energy for contraction. It turned out to be distinctly low, which is consistent with the fact that all sloth muscle seems to fall into the category of what is known as red, or slow, muscle.

Slow muscle is biochemically different from fast (or white) muscle and Toole and Bullock conclude that sloth muscle has a low contracting speed by the very nature of its contractile proteins. However, this alone simply would not make the sloth as slow as he is. The rate-limiting factor for sloth motion is to be found in the central nervous system. And indeed, it is the nervous system that to some extent determines the nature of the muscle. In immature mammals, as in sloths, all the muscle is red. Later, some turns white under the influence of trophic substances released by the nerves. It may be that these substances are missing from sloths. But since no one has yet discovered what they are, there is no obvious way of finding out.



Chromium sandwiched in vapour technique

Conventional methods for the preparation of "sandwich compounds" of chromium, where the chromium atom is sandwiched between two unsaturated organic ring systems, have completely failed when the rings contain substituent groups such as chorine or fluorine. Apart from the interesting chemical and structural aspects of these compounds, their use in producing metallic mirrors and conducting coatings on resins and plastics is providing an area of active research. In a recent paper in the Journal of the American Chemical Society (vol 95, p 3337), Philip Skell, D. L. Williams-Smith and Michael McGlinchey report the synthesis of these compounds using a novel and relatively simple synthetic technique.

Skell and co-workers at the Pennsylvania State University use a method, developed in the last decade, which involves the production of a vapour of chromium metal. The very reactive chromium atoms so formed, together with the vapour of the appropriate organic compound, are trapped by condensation on a cold area (−196°C) of the reaction flask. When suitable quantities of chromium and organic compound have been cocondensed, the system is allowed to warm and, surprisingly, the reaction to produce the sandwich compound occurs. The new compounds can then be extracted by solvents, or sublimated, and then investigated spectroscopically. Since the same technique (using chromium atoms) can be used to trimerise acetylenes and isomerise alkenes, further work in this area will undoubtedly provide some fascinating results.

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Pulling together theories on atherosclerosis

Atherosclerosis, in which thick "plaques" form in the artery walls that carry blood in the brain or heart muscle, is now the chief cause of death in males in Western societies. Prevention and cure seem a long way off; but two new hypotheses of how plaques develop, hypotheses that are contrasting but may prove to be complementary, have now emerged from two groups at the University of Washington School of Medicine. Both maintain that proliferation of smooth muscle in the artery walls is the fundamental pathological change. But the first, more conservative, hypothesis states that proliferation results when the thin lining of the artery is damaged, so that the smooth muscle in the artery wall is exposed to certain components of the blood plasma. The second holds that the smooth muscle cells in a atheromatous plaque all derive from a single mutated cell —in other words, that the plaque is a kind of smooth muscle tumour.

Muscle is the culprit

The healthy artery of a young child has a thin inner layer, the intima, which consists of a one-cell-thick lining of endothelial cells and thin perforated layer of elastic tissue. As age advances, smooth muscle cells slowly accumulate within the intima, and so thicken it. The lesions that characterise atherosclerosis primarily affect the intima.

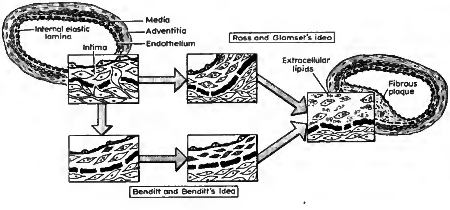
The first of the Washington University groups, Russell Ross and John Glomset, point out in Science (vol 180, p 1332) that the fundamental cell type in all lesions is smooth muscle. Whether the smooth muscle cells in the plaques come from those present in the ageing intima, or invade through from the media, is not clear. In any case, the more fundamental question is why they should proliferate to form plaques.

Ross and Glomset point out that plaques normally accumulate where the arteries branch, and the intima's permeability is increased. And when these workers stripped the endothelia from the intimas of young macaques —whose basic arterial structure is like that of a child's—several layers of smooth muscle built up inside the remaining elastic layer, in place of the missing endothelium. They therefore suggest that "the intact arterial endothelium normally acts as a barrier to some substance or substances present in plasma which upon exposure to vascular smooth muscle promote cell proliferation".

What are those growth promoting substances? It turns out that plasma proteins—particularly lipoproteins—are responsible. Possibly, say Ross and Glomset, the proliferating cells need plasma lipoproteins as a source of lipids to be used in cell membranes. This begins to tie in with the observed relationship between a high plasma cholesterol level, and a high likelihood of atherosclerosis: cholesterol is water-soluble only when it is a component of a lipoprotein. It seems, too, that when the plasma contains too much lipoprotein, the smooth muscle cells accumulate it.

Ross and Glomset's hypothesis, while neatly accommodating many of the loose ends in the atherosclerosis natural history, is essentially a third generation development of Rudolf Virchow's suggestion of 1856—that artery-wall cell proliferation begins with irritation of the arterial intima. More radical is Earl and John Benditt's hypothesis, now reported in Proceedings of the National Academy of Sciences (vol 70, p 1753), that all the smooth muscle cells in the plaque derive from a single transformed cell, and that the plaque is therefore a benign smooth muscle tumour.

Benditt and Benditt point out first that none of the "chemical, mechanical, and nutritional manipulations" used in animals to produce experimental atherosclerosis have ever yielded really convincing copies of the human lesions. Chickens, however, do develop atherosclerosis naturally. And, say Benditt and Benditt, the cells in the spontaneous lesions of both humans and chickens differ from those of the normal artery wall—and from those that can be induced experimentally to populate a repair site. The spontaneous lesion cells are smaller, are not accompanied by the same extracellular material, and do not have junctions between them. So, say Benditt and Benditt, the spontaneous plaque cells either derive from cell populations other than those of the arterial media, or they are transformed—mutated—cells. Since it is extremely unlikely that the same mutation would occur many times in different cells in the same area then —if a mutation is indeed the first event in the development of the plaque—all the cells in the plaque must be derived from the same mutated cell.



There is a cogent method of testing this. In female mammalian cells, one or other of the original X chromosomes is permanently switched off. Since the switch-off apparently occurs randomly, the female mammal is a mosaic—some cells containing the X chromosome derived from the father, and some the one derived from the mother. Some enzymes—including glucose-6-phosphate dehydrogenase—are X-linked. That particular enzyme occurs in two distinct forms, A, and B. Some women, including about one third of negresses, are heterozygous with respect to that enzyme. Some of their cells produce A dehydrogenase, and some produce type B.

Plaques from one cell

Benditt and Benditt tested atheromatous plaques from four women who were heterozygous with respect to the enzyme. And each of those plaques contained, predominantly, only one variety of the enzyme. Equivalent size tissue patches from healthy parts of the women's arteries contained reasonably balanced amounts of both varieties of enzyme. So it seemed all the cells in the plaque had indeed arisen from one single cell.

Can the ideas of Ross and Glomset, and of Benditt and Benditt, be reconciled? The answer is that they can, and easily. Benditt and Benditt point out, as did Ross and Glomset, that atherosclerotic plaques tend to occur where there is a high turnover of endothelial cells, and consequently a high turnover of smooth muscle medial cells. And while this fast proliferation does not by itself give rise to true plaques, it may make the rapidly proliferating cells more susceptible to the transforming action of mutagens. *Colin Tudge*

A global view of cells gets the green light

There has been a powerful trend in biochemistry recently away from the analysis of single biochemical processes taken in isolation and towards the study of the organisation and integration of these processes within the cell. This trend, which has resulted in the discovery of a varitey of forms of enzyme association and sub-cellular segregation of functions, has now led to the discovery of "lumisomes", sub-cellular particles present in animals which emit light. This phenomenon, bioluminescence, which is found in numerous animal species, is a process requiring some interesting chemistry. The light emission comes from a molecule in an "excited" state, but the production of the "excited" molecule must obviously arise only from conventional chemical reactions—no laser beams or high energy particles are permitted! James Anderson and Milton Cormier of the Department of Biochemistry, University of Georgia, US, have been studying bioluminescence in many coelenterate animals (such as jellyfish) which emit a characteristic green glow (Journal of Biological Chemistry, vol 248, p 2937).

Up to date, the analysis of the details of coelenterate bioluminescence has been rather fragmentary. From some species a protein has been partially purified which emits a blue flash when calcium ions are added. In some other species, a series of chemical reactions has been established leading to blue light emission from the compound oxyluciferin; luciferin and oxygen interact with the enzyme luciferase to generate "excited" oxyluciferin which emits the light. Note that in neither case is the emitted light green although this is the characteristic emission from the intact organisms.

What Anderson and Cormier have done is to pick up some hints that there might be a fluorescent protein also involved in the bioluminescent process. They have confirmed this and have shown that either of the emitter systems mentioned above can transfer "excitation" to the fluorescent protein, which then emits green light corresponding exactly to the light emitted by the whole organism. They have also showed that this interaction between the fluorescent protein and the other components requires quite high concentrations of all the components. In the cell this could only be achieved if all components were packed into a membrane-bound particle, so that the local concentration was high. Sure enough, all the coelenterates examined turned out to contain small subcellular particles which, under the right conditions, emitted the characteristic green light. These particles, which Anderson and Comier call "lumisomes", contain all the various molecules which have previously been identified as part of the bioluminescent system.

So the list of sub-cellular organelles increases, and lumisomes take their place with lysosomes, peroxisomes and the rest.

Tipping the reaction balance by reverse osmosis

Stewing up reactants in the preparation of, say, organometallic complexes is not, as is often imagined, the critical part of the synthetic procedure. Once the desired product is in the reaction vessel it has to be separated from the ligand material, the solvent, and any unwanted by-products of the reaction. Although this is not generally difficult, a problem occurs with ligands that are nonvolatile. A simple example of this separation problem can be illustrated by the reaction:

$$RuH_2\,(PPh_3)_4 \rightleftharpoons RuH_2(PPh_3)_3 + PPh_3$$

where the triphenylphosphine (PPh_3) ligand is unwanted; the ligand-deficient compound, $RuH_2\,(PPh_3)_3$, being industrially important as a homogeneous catalyst. If the PPh_3 ligand could be removed from the solution the catalytic activity would be expected to increase. Since PPh_3 is a non-volatile ligand the problem of how to remove it has only recently been solved by L. W. Gosser, W. H. Knoth and G. W. Parshall who report in the Journal of the American Chemical Society (vol 95, p 3436).

Using the technique of reverse osmosis, where a solution is forced through a selectively permeable membrane under pressure, the workers manage to remove the PPh_3 from the $RuH_2(PPh_3)_3$ using fairly simple apparatus, and the expected enhancement of catalytic activity is achieved. Apart from this important result, and other avenues of research that this opens up, George Parshall and his co-workers at E. I. du Pont de Nemours and Co, (Wilmington, Delaware, US) have also extended the technique to isolate previously unknown compounds by using nitrogen as the pressurising gas. The nitrogen gas can react with this type of ligand-deficient compound to give a new compound containing a discrete nitrogen molecule. These new compounds have become interesting additions to the ever-growing list of inorganic componds which have been shown to "fix" nitrogen.

An Earthward plunge paves way to planets

Before you send probes to investigate the atmospheres of other planets, it is a good idea to try them out on an atmosphere of known properties first. That is the logic behind a highly successful NASA probe whose belatedly published findings confirmed recently a lot of known information about the Earth, and supplied a lot of unknown data about the performance of such probes entering a planet's atmosphere from space.

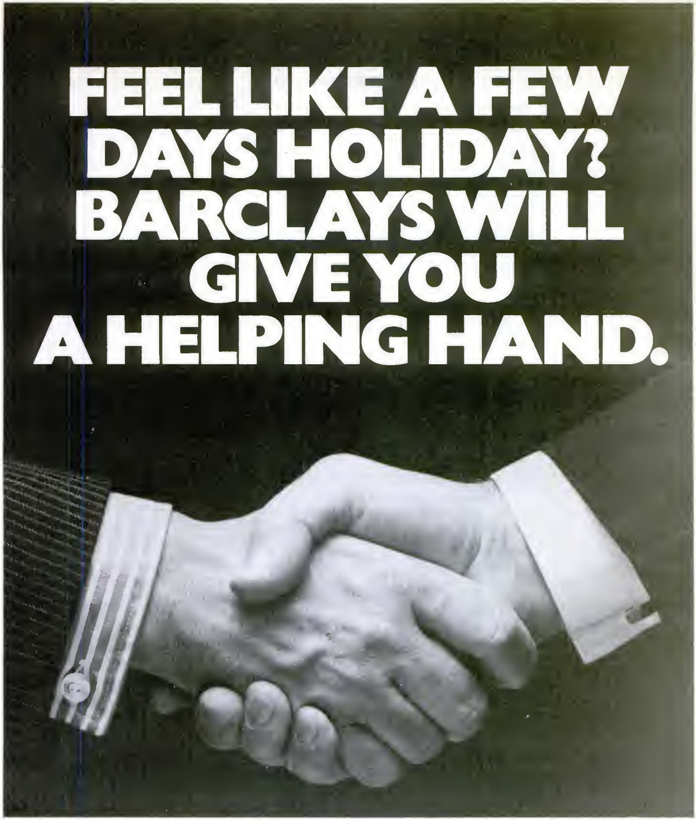
The Planetary Experiments Test vehicle (PAET) was a blunt, one-metre-diameter cone weighing 62 kg of which 14 kg were instruments. It was flown as long ago as 20 June, 1971, entering the Earth's atmosphere at a velocity of 6·6 km/s off the Atlantic seaboard near Bermuda.

Dr Alvin Seiff and five colleagues from the Ames Research Center and the Goddard Space Flight Center have now described the PAET experiment in Icarus (vol 18, p 525). From an altitude of 90 km until impact, a mass spectrometer and a spectral radiometer measured the composition of the atmosphere, while other experiments determined the performance of the heat shield and monitored the probe's general dynamic behaviour. The trajectory simulated a steep hypervelocity entry, at a Mach number above 20 and involving peak deceleration of 75·8 g. The ability to make high-speed measurments is vital to such probes. Speeds of this order will, for example, take the Viking Mars landers rapidly through the ionosphere and upper atmosphere of Mars, where planetary scientists hope to carry out important experiments.

The PAET vehicle, launched by a Scout from Wallops Island was boosted to apogee of 377 km by the first two stages of the rocket. The final two stages accelerated the vehicle into its high-speed entry path, and the total range from launch to impact was just over 1100 km. The experiments were "largely successful", and the instruments recorded clearly such features of the atmosphere as known reversals of the temperature gradient. The radiometers provided accurate data on the bulk composition of the atmosphere and traces of carbon dioxide; and the mass spectrometer functioned correctly although problems were encountered with its sampling system.

It is not the "successful" parts of the test which will be of most benefit, however, but those where partial failure points the way to improve similar probes intended for launching to Mars and Venus within a couple of years, and to the outer planets later. The random buffeting of the probe at low speeds, which would interefere with accelerometer readings, suggests that great care must be taken in choosing the shapes of planetary probes. The performance of the heat shield was also not quite all that might have been desired—it seems that it was contamination from the ablating shield that affected the mass spectrometer sampling system.

This kind of detailed improvement will ensure the almost certain success of the Venus, Jupiter and Saturn probes which are not intended to survive landing, and will also benefit some of the Viking experiments The second stage of the scientific exploration of the solar system thus seems to be firmly established.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Freightways of tomorrow?

The canals, presently neglected, could and should play a vital role in a more rational policy for freight transport in Britain

Ian Breach
is a freelance writer on transport and environmental matters, and former motoring correspondent of The Guardian

One of NASA's biggest headaches at the end of the 1960s was in solving the problem of how to transport larger and larger pieces of hardware from manufacturers and assemblers around the country to the launch area at Cape Kennedy. Too heavy to be airfreighted, too big to go by road or rail, some of the space vehicles eventually arrived by the oldest transportation system of all—by water: they came on the wide, deep, and commodious inland waterways of America, which now has more than 25 000 miles of navigable canals and is exploiting them as never before.

Using modern barges, often in a flotilla of many individual units, and fast developing the network by canalising rivers and improving existing channels, the US is today carrying over 500 million short tonnes of its goods and produce on the Federal and New York State canal networks. But though that represents a 25 per cent increase in total weight over the figure for 1960, the proportion of freight taken by water has remained fairly constant over the years at about 14 per cent. At a time when the developed countries' transport mix is so closely under scrutiny for environmental and resource reasons, it is vital to ask whether the canals could take significantly more than this share of the burden, and—if they could—whether they would be materially easing our problems.

If energy efficiency alone were the criterion and current trends in transport growth and availability/price of diesel and low-grade motor spirit were to be continued, the canals of the world would receive high marks. Eric Hurst's study, done for the Oak Ridge National Laboratory a little over a year ago, threw up the following comparisons for modes of inter-city freight transportation:

	tonne-mile/gal	Btu/tonne-mile
Pipelines	300	450
Waterways	250	540
Railroads	200	680
Roads	58	2340
Airways	3·7	37 000

Pipeline transportation already accounts for more than a quarter of the total freight "traffic" in the United States measured in tons carried: it has its obvious attractions as well as limitations, and it is one of the transportation systems likely to benefit massively from multi-national operations in Europe.

Measured by tonne miles, however, pipelines in America transport only 17 per cent or thereabouts; similarly with canals, the net tonnage proportion of 14 per cent is reduced to barely 9. By contrast, trucking tonnage accounts for a surprisingly meagre 10 per cent—but generates a tonne-mileage figure of 22·5 per cent. It would seem that heavy goods vehicles are generally transporting fewer loads longer distances—by a factor of up to 3·5. The conclusion is borne out by British experience: the tonnage carried by water is exactly twice, by proportion, the route-mileage share. Apart from this statistic, sadly, the figures defy unravelment: the Department of the Environment and the British Waterways Board tabulate on different bases in any case, but even on conversion produce irreconcilable data; PEP in London and the European Commission in Brussels respectively treble and double the inland freight percentages for waterway. Allowing for the discrepancies, though, it is clear that the movement of goods by canal is a much more deliberate and purposeful affair than by road. The use of container lorries does not seem to have brought about any increase in overall system efficiency: indeed, it may be concealing a worsening situation. Unplanned, haphazard load movement is difficult to detect and plot on a national scale, though it is obviously easier when open trucks present themselves for visual inspection.

My own research, conducted on the A1 five miles from the centre of London, indicates a fairly constant standard for open commercial vehicles—1 in 3 travelling only partially loaded; 1 in 5 travelling empty; and 1 in 12 passing HGVs carrying similar loads in opposite directions (the price, admittedly, of a free enterprise system as practised on the roads). Weighbridge returns from the cross-Channel ports show far more container trucks loaded below capacity than the overloaded ones which are rightly being pulled off the road. The road-haulage figures show, in fact, that the vast majority of freight carried by road in Britain consists of loads of between 3 and 5 tonnes taken fewer than 25 miles. Even for loads over 8 tonnes, the largest proportion is being trucked in this distance band—invariably in areas where there is canal or developable waterway capacity (and inward-bound goods almost precisely equal those outward bound in all the economic planning regions). The question must therefore be whether a more rational general transport policy could be devised for the carriage of goods in Britain and, if so, whether the canals could play a serious role within that policy.

A major change of attitude on the part of central government will be the first essential. It has promised a policy guideline on transport for the autumn of this year: while one would not want to pre-empt such a welcome if late development by anticipatory criticism, the government is unlikely to attach much if any importance to waterways as part of Britain's transportation network. It has repeatedly turned down requests for aid to the British Waterways Board, insisting that proof of economic viability "in the form of guarantees" must be furnished before it can put up money towards the cost of expanding and rehabilitating the canals. This is, of course, an illogical demand: no one who provides a service (and motorways are as good an example as any) can *guarantee* that

the service will be used, and the yardsticks used to measure "viability" in transport are demonstrably warped by the many pressures of special interest. It is not as though there was a shortage of waterway costings available to the government: it has, for instance, declared itself "unable" to approve the BWB's proposal for improvement of the Sheffield and South Yorks Navigational Canal on grounds of cost-effectiveness, but a shrewd and quickly exploited study of costs not many miles away shows how wrong the Department of the Environment could be.

At Knottingley in Yorkshire, a barge-tanker operating company, John Harker, has been carrying 500 tonnes of oil from Hull to Leeds in single trips, using a crew of three and taking 16 hours over the journey. If the same number of men were to drive a series of 20-tonne road tankers, it would take 50 hours of continuous haulage to move the same quantity. Esso, which tried the canal scheme here, finally adopted it and reported a one-third cut in transport costs. Kenneth Gilbert, project director for the Port of Toronto, has put the comparative extravagance of other forms of freight with canal shipment even more dramatically than Hurst: with bulk cargoes such as ores, more than 1000 tonne-mile per gallon of fuel have been obtained from vessels in the authority's operating area. Only the Rhine, in Europe, could offer figures as good as these ones from the St Lawrence Seaway, but at least they show a performance of 250 tonne/mile-gal to be a realistic base.

What the BWB must do, as British Rail has had to do, is to assail the government with more than pleas for survival. It must hammer home the comparative surface-transport cost for competing modes. The Sheffield and South Yorks proposal called for a total of £2·4 million to be spent on a stretch of water 35 miles in length, expanding and reconstructing it to take vessel systems of up to 750 tonnes: spent on highway building, the same sum would barely buy a mile and a half of open motorway and would not cover the costs of half a mile of elevated urban freeway. Not only would operating costs be cut by 25 to 30 per cent (on traffic estimated by independent consultants to rise from 500 000 tonnes to 2 million tonnes a year if the scheme went through), but the quantifiable environmental relief given to this part of south Yorkshire would be enormous. Most of the projected total traffic increase would come about in any case, much of it generated by British Steel's planned £23 million plant near Rotherham. If this were to go on the roads, the region would need not just one M62, but two—with double the hidden subsidies that presently close the gap between what road users pay and the cost.

It is impossible to spend £2·4 million on *any* length of road and bring about a fourfold increase in capacity—but even this hypothesis omits the fact that £2·4 million spent on road would buy road and road alone. It would not buy police and ambulance staff, maintenance equipment, labour, and materials; it would not pay for motor industry imports, nor any of the multitude of charges incurred in road transportation which are not incurred on water. If true comparison were possible, my guess is that freight conveyed by inland waterway would cost the community as a whole at least five times less.

There are other environmental advantages to taking goods by water. One is that mentioned in the Toronto report, which notes that the larger vessels produce 373 per cent less pollution, by volume, than diesel trucks (based on cargo carried). A second is that a waterway can transport far more freight, bulk for bulk, than an equivalent width of road (or rail)—thus making far lower demands on land. It is not important to have speed as a prime factor: continuity of supply is much more critical to the industries which—in an ideal world may be—would use the canals as a feeder network. There can be no question that the network exists in Britain —the BWB has about 2000 miles of inland waterway under its wing (roughly two-thirds the mileage that existed at the end of the great canal era 120 years ago). But only 350 miles of this is designated as "commercial" under the 1968 Transport Act.

The waterways lobby—a large if not powerful group—has not been slow to point out that the one factor distinguishing this rather pitiful state of affairs from that on the Continent is money. Germany, which carries rather more than a quarter of its goods by inland waterway, plans to spend £60 million annually for the next five years on various improvement schemes. Investment on a comparative scale is being made in Holland (66 per cent by inland waterway), Belgium (29 per cent), and France (31 per cent).

By contrast, British waterways are in monetary limbo—nominally the responsibility of the State but run mainly by economically feeble private operators: it is probably precisely the situation the railways would have found themselves in today had they not been nationalised. Uneconomic (ie, low profit) lines would have been closed much earlier, much more widely, and with even less concern for the public interest than they were under Beeching. Rehabilitation of the canals, however, would be a far easier job to tackle than

A programme for reform

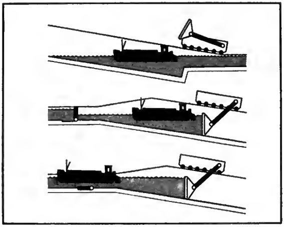
Those anxious to rejuvenate and expand the waterways of Britain have a reasonably concerted view of what is required. Summed up by the canal enthusiast and former BWB member, Charles Hadfield, the programme would fall into four main parts:

1 Creation of an inland waterway division within the DoE, technically similar to the motorway division and those in other countries, given principal engineering and technical staff and able to initiate and plan national waterway development.

2 Transfer of the BWB's carrying fleets and ancillary services to a National Freight Authority, with services to be parallel to the development of private carrying.

3 Granting of legal powers to the new local authorities to finance inland harbours of their own (as American and European towns do).

4 Provision of all capital for new building, reconstruction, and maintenance of canals from State funds as in Germany, France, Belgium, Netherlands, and the United States: the government would pay for "track", cities for the port facilities, and carriers for the craft.



Working of the water slope—one of which is now being constructed on the Canal lateral a la Garonne, in SW France

any major restoration of rail services. A good basic grid exists—which serves most of the country's industrial towns and cities—and the technology has been brought up to date, particularly in the Netherlands and Germany, where scores of expansion and development projects are now under way. Politically, it would need a totally reconstituted authority, working and costed as British Rail and its board is *supposed* to be.

How much more freight could the canals of Britain accommodate? It is not a straightforward question to answer, but with little or no development at all, the present system could accept three times more traffic, according to BWB figures. With only modest additional expenditure (like that involved in the South Yorks plan), it could bear between 8 and 10 times more. With investment of the sort being taken for granted in other European countries it is clear that the capacity could be hugely expanded, but only if that investment included the development of all the necessary linking facilities, the logical siting of new factories, in fact a whole new attitude to waterways that mirrored what is going on in the rest of the world.

Russia, for example, has just completed a 3500-mile deep-waterway system in the European USSR and is planning to join it with the canals of adjacent countries and the proposed waterways of Siberia, the extreme north, and the Russian Far East. As Frederic Doerflinger, chairman of the Inland Shipping Group points out, Britain is separated from all this by a short, free stretch of water: in Europe, more new large waterways are being built than new railways "while we have shamefully neglected our waterways".

Along with the improvement of the canals themselves has come the 20th century's answer to the narrowboat—the barge-carrying ship. Given the ideals of a large transhipment port, inland centres served by it, and navigable rivers or practicable canal courses, the pickaback vessel is a natural component. There are now three such basic systems—LASH (Lighter Aboard Ship), Seabee, and the BWB's BACAT (Barge Aboard Catamaran). LASH was developed by Lash Systems Inc of New Orleans as a vessel design in which lighters can be quickly and easily loaded and unloaded by shipboard crane at the rate of four per hour (equivalent to 1400 tonnes of cargo). The ships themselves can operate independently of ports, requiring no more than adequate depth of water, secure mooring, and room to swing.

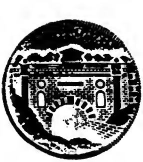
More than two dozen LASH ships are now built or under construction, each one capable of carrying between 73 and 89 lighters. Once lowered from the parent vessel, the lighters are moved inland or to wharf by tug or push-tug; linked together they can be incorporated with other barges in push-tows (in the West European canals they thus fit the 9·5 m locks which take a Continental standard barge of 1350 tonnes).

Seabee, another commercial venture originating in the US, carries a mixture of containers, roll-on, roll-off vehicles, and much larger barges—some 38 832 tonners. These are shipped and unshipped by an elevator which can handle two barges at a time. The well-known authority on waterways and canal hardware, Charles Hadfield, is conspicuously unenthusiastic about Seabee, which he says "seems partially to have been designed for its military value". Certainly the barges are acceptable in only the larger Continental and Mississippi system locks.

BACAT has yet to operate. Designed for the Waterways Board and to be registered at Grimsby, the first vessel is due to be delivered by its Danish builders at the end of this year. The ship carries 18 barges—10 on deck and eight slung between its two hulls. Each barge can carry between 100 and 140 tonnes (depending on draught) and has the same dimensions as those now operating on the Sheffield and South Navigation. Push-tugs and barges for use with the parent ship are also being built at the moment. One tug and three barges will work as a unit slightly less than 200 ft long and 15 ft wide, but the tug can, if necessary, push up to nine barges. Alternatively, the ship will carry 10 BACAT barges and three LASH lighters—making it possible to shuttle American, Continental, and British freight

The benefits of using barge-carrying vessels hardly need spelling out, but physical flexibility, low capital and operating costs, and high energy-efficiency are obviously three of them. Any device which can directly link the existing canals of Britain—let alone an expanded network of the future—to the great trade-catchment waters of America and Europe must be a triumph: in this case, it is one of great simplicity. The best triumphs always are. There are no revolutions in naval architecture, no new and untried handling equipment, no false "economies of scale". But Britain will not benefit greatly unless it is prepared to treat the canals as their potential warrants.

No one, even the BWB and the IWA, is saying that the country's waterways can take all the freight off the road. But if the sums were done properly, they (and the railways) would be carrying very much more freight than they are now. By then we might also have rationalised our whole transportation policy and be reducing freight traffic, for as it is, we carry a whole lot of coal to a great many Newcastles.



Here comes the Sun

Last week more than 600 scientists met in Paris to discuss the many problems that face the harnessing of solar power as an answer to man's energy needs. Earlier claims have come to nothing, and there must now be a realistic discussion of solar energy

Michael Kenward

With the energy crisis throwing even the United States into a tizzy, solar power is now an R&D "growth stock". The Sun has long been recognised as a possible answer to man's energy needs, but many previous bouts of enthusiasm have come to nothing as the promises of scientists have proved groundless, and as even more revolutionary energy sources (such as oil at the beginning of the century) have come along. The only alternative to fossil and fissile fuels—thermonuclear fusion—is still far from guaranteed, so scientists and engineers are busily showing that even if fusion power proves disappointing we will not be plunged into darkness as the oil wells run dry, the coal mines are exhausted, and uranium supplies run out.

There are many technological possibilities for solar energy. Most of them are well enough understood to convince all but the most sceptical that the Sun can contribute significantly to man's energy supplies. The question is, can we develop these technologies so that the energy is available at a price we can afford? The fuel for a solar power plant is free, but the capital cost can be very high. It does not matter how efficiently we can turn the Sun's radiation into electricity, hot water, distilled water, cold air, or what have you, but the cost of these "products" is very important. This was a continuously recurring theme at the international congress on The Sun in the Service of Mankind, held in Paris last week.

Unlike thermonuclear fusion, the feasibility of harnessing solar radiation is not in doubt; but before we can plug into the Sun many technical questions still have to be answered. Indeed, George Lof, professor of civil engineering at Colorado State University, believes that there are many questions that the solar energy community has not even considered.

Two views of the Sun

One question that is basic to the direction of solar energy R&D in different countries is the use to which solar power is to be put. In the United States, scientists such as Aden Meinels talk of "photo-thermal solar power farms", covering many square kilometres of land (New Scientist, vol 58, p 337). At first, these would be simply added on to existing power stations—a concept dreamed up by electricity utilities.

In the developing countries ambitions are more modest. Delegates from different parts of the world last week described similar progress with units such as Sun powered desalination units, cookers, engines, and heaters. In these countries the idea is not to use solar radiation as a substitute for other fuels, but to help many millions of people achieve a standard of living they cannot hope to achieve with conventional energy systems.

H. P. Garg and A. Krishnan from the Central Arid Zone Research Institute, Jodhpur, India, told the congress that "In a developing country like India the utilisation of solar radiation . . . is extremely important in view of the chronic shortage of conventional sources of power. Though much emphasis has been made in many national and international conferences on the utilisation of solar energy for various domestic applications like water-heaters, room heaters, agricultural drying, desalination, and so on, not much progress has been made in the actual use of solar energy."

Unesco, which was a co-sponsor, with the French government, of last week's congress, realises that something has to be done if all countries are to benefit from the development of solar energy. During the week before the 600 congress delegates got down to the hard work of ploughing through hundreds of papers, a select band of experts was brought together "to advise Unesco on a possible future programme in solar energy". This 13-man working group feels that the state of solar energy is such that a small effort could dramatically increase international understanding of solar power technology, and of the problems facing its introduction.

The Working Party came up with a series of conclusions and recommendations. One conclusion was that "an international solar energy programme would bring economic and social benefits to many countries, developed as well as developing. Such a programme might help to prevent the gap between these countries from becoming wider." The Working Party also concluded that for a change, "there is a remarkable absence of negative factors which would tend to inhibit international co-operation". And Unesco is ready to take on the job of coordinator. The level of Unesco's effort will depend upon how much pressure member countries bring to bear. The most ambitious of the programmes discussed by the working party (for an international solar energy decade) would call for significant international agreement. The Working Party of solar energy experts suggested that such a "massive internationally funded and directed research and development programme for the attainment of specific objectives, should receive wide discussion among scientists in member states".

High technology

While electricity generation by solar power may be the most interesting technical problem, the United States also sees other possibilities. William Cherry and Frederick Morse, in a paper describing the conclusions of the US solar energy panel (New Scientist, vol 58, p 36), told the congress that "three broad applications areas have been identified by the panel as most promising from technical, economic, and energy standpoints. These are: heating and cooling of buildings; production of clear renewable fuels; and the generation of electrical power." Something like a half of the $12 million that the National Science Foundation is spending on solar energy this year will go to the first of these three areas.

Just as the delegates to the congress were travelling to their Paris meeting place, President Nixon was adding to his previous energy message (New Scientist, vol 59, p 2). The solar energy community cannot expect to gain any of the extra $100 million that Nixon wants to spend on energy R&D next year. According to Dr Paul Donovan, chairman of the NSF energy task force, and a co-chairman of the NSF/NASA solar energy panel, the solar energy community is already stretched to the limit of its R&D capabilities. And to a certain extent, any further spending will have to await the results of the studies that are now under way.

The sudden increase in solar energy R&D funds has not all gone into hardware, as it might have done in earlier days. The NSF is spending money in an attempt to find out how it should channel its future solar energy programmes. So to begin with it is spending money on assessment studies—of both the technology and its social and environmental impacts.

A question of size

The need for this spending is immediately apparent when you talk to some of the advocates of solar energy. There is considerable argument within the community as to which is the right direction for solar energy research to take. What is the right size for a solar powered electric generator, for example? As Professor George Lof says, power plant size "is a very important variable which perhaps hasn't been given the attention it deserves, and which we feel is not at all clear as to the direction in which we should be working. Assumptions have been made that a solar power plant has to be large to be useful. Fossil fuel and nuclear plants are made large and they seem to be getting bigger all the time; but solar energy is a different type of energy. It isn't a concentrated form, so we need to spread a power plant over a large area. Based upon the knowledge we now have, this means replication of many small units. And economies of scale do not operate nearly as effectively when you are just replicating small units as when you make units progressively larger."

Lof says that he is not "making a plea for tiny solar power plants, but let's not assume that they are going to be really big unless we find that this is an economic power plant size."

Aden Meinels also warns against sticking to preconceived notions. "We are not after maximum efficiency, we are after the maximum number of kilowatt hours per dollar. You may have the option of operating at 200°C at about 12 per cent conversion efficiency. If you go to a higher temperature you may have 25 per cent efficiency. But you can only spend twice as many dollars if you are to have equal payoff. If the higher temperature and efficiency mean going to concentrating systems that only work half of the time, you cannot afford to spend any more money than you would spend operating at 12 per cent efficiency. It took us a long while to learn that." Meinels said that his team is now "tending to concentrate on inexpensive collector systems operating at low temperatures".

Collecting problems

Other major technical problems facing solar energy advocates concern the collectors: should they be flat plates with no concentration, or should they be optically focussing systems? Or will it be possible to employ both types of collector in the same plant? And should electricity generation be photoelectric or thermal, as Meinels and Lof believe?

A more significant question is the weather. Aden Meinels's team soon discovered that the Sun does not shine as much as we think, and the weather records do not give a true guide to the amount of time the weather is suitable for solar energy generation. If the need for energy is linked to its availability, all is well—and here solar energy advocates look to air conditioning as a natural home for their wares—but if you want a solar power plant to provide base load, then all is not well. What happens at night or when clouds are around?

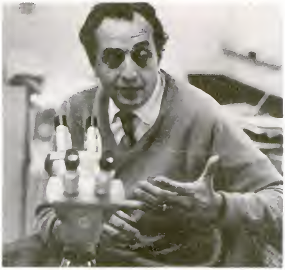
Peter Glaser, of Arthur D. Little, has been a long time advocate of satellite systems. These would collect solar energy with huge arrays of photoelectric devices, and convert this into microwave radiation that would be beamed to Earth-bound collectors. Satellites would not suffer from "night starvation" and ground stations could be built anywhere. The reception accorded to this idea was surprisingly hostile. One satellite engineer with considerable microwave experience thought that the whole idea was totally unnecessary. Environmentalists complained that such a system was adding more heat to the world's ecosystem, by reducing atmospheric losses.

Less controversial ideas were suggested for coping with the storage problem. These ranged from sophisticated systems with molten salts, to the suggestion that perhaps a solar energy plant should be linked to a hydrogen generating plant. The hydrogen could then be burned as a replacement for solar heat during the night and when the weather was bad; or the hydrogen could be a contribution to the fuel cycle.

Solar energy scientists are working at a time when there are far more problems to be considered than there were when, for example, nuclear energy was getting under way. The development of solar power is not just a case of producing a new furnace and offering it in the market place. Solar energy has to slot into a complex energy situation—it has become fashionable only because of this growing complexity—and it has to satisfy strict environmental constraints. The questions that have to be answered before solar energy begins to make its presence felt go beyond science and technology.

A man who listens to nature

Dr Robert Good, one of the world's best known immunologists, recently became director of the Sloan Kettering Institute for Cancer Research in New York. Here he talks to Dr Roger Lewin about the interrelationship between immunology and cancer



"Cancer cells kill people because they don't obey the rules. They don't listen to the stop signal. What I want to do", says Robert Good, "is to learn to talk the cells' language; to tell cancer cells to stop, rather than go". Cells communicate with each other using what Good has called the third biological language. It must be a very simple language, he insists: "it's a binary system—on or off—I'm almost convinced". Good intends to learn the language by turning New York's Memorial Hospital—which overlooks Eastside Manhattan—into a powerful instrument for looking at cancer. As well as providing the best possible care for cancer patients, the hospital should pose probing biological questions. "Because cancer cells are immortal", Good says, "they must hold the key to life."

Before coming to the Sloan Kettering Institute for Cancer Research at the beginning of this year, Good spent 31 years at the University of Minnesota. While he was there he played a major part in generating the current flood of knowledge and excitement that characterises modern immunology—the study of the body's defence mechanisms. During those three fruitful decades Good spent his time going to and fro between hospital clinics and research laboratories. His whole approach to solving basic biological problems is to learn from naturally arising clinical situations, what he likes to call "experiments of nature". These he takes to the research laboratory for analysis. Now that the science of immunology is so deeply enmeshed with cancer research and treatment it seems right that Good should take his very special talents and enormous energy to New York's famous combined cancer hospital and research institute.

Good is not a modest man. Indeed, he has 30 or so years of significant scientific achievement to be immodest about. But those people who accuse Good of arrogance and a tendency to assume more credit than may be his due, concede that he very readily recognises and admits to any errors he makes. Perhaps the most obvious of Good's characteristics are his infectious drive and enthusiasm and a remarkable capacity for hard work. At the beginning of his career—in the mid-1940s—he took an MD and PhD simultaneously, a feat that demanded day and night working. Even now he gets by on the minimum of sleep. Work begins at 5.00 am for Good. He simply walks down from his apartment perched on top of the Institute to his office on the 13th floor. My interview with him started at 6.00 am, probably one of the best times of day to see the streets of Manhattan.

The current picture of the mechanisms by which our bodies attack foreigners—such as viruses, bacteria, fungi and cancer (which invades from within)—is basically quite simple. The immunological armoury operates in two divisions: the antibody (humoral) response which is induced by infection with so-called high grade encapsulated bacterial pathogens (pneumococci and streptococci for example); and the cellular response which comes into action against low grade pathogens (Mycobacterium tuberculosis, herpes virus, and certain fungi, for instance), organ transplants and cancer (see Figure 1).

The existence of this dual system of immunity emerged slowly over a long period, particularly over the past 15 years or so. There was no once-for-all discovery. Evidence accumulated from many different directions; theories were proffered, tested, demolished, and reformulated; finally the present picture became established—a perfect example of how science evolves. Throughout this time Good dissected vital clues from the experiments of nature he so liked to discover and understand. Often he felt intuitively that the things the clinical situation seemed to imply were right, in spite of contradictory evidence in the research laboratory. His faith in what nature has to say is very deep.

After a far from easy childhood—which involved a long and determined battle against paralysis in the legs, the residue of a serious illness—Good joined Berry Campbell at the University of Minnesota. He was working "in a very desultory way" on herpes virus infections in the central nervous system. Although he quite enjoyed the pathology involved, he was bored by neurophysiology and was looking for something else to do. One night Fred Kolouch, another scientist at Minnesota, came along to Good's laboratory and said "Why don't you do something important? Come and help me work out my problem". Kolouch had been taking care of a patient with subacute bacterial endocarditis—a fatal infection involving streptococcus viridans.

What intrigued Kolouch was that the patient's tissues were teeming with plasma cells. Four years earlier Kolouch had tried some experiments on rabbits to try to un-

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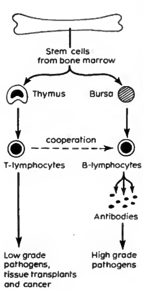

ravel the role of the plasma cells. Many people dismissed these cells as having no important function, as being merely passive. But Kolouch was not so sure. He made a vaccine from S. viridans and injected in into rabbits. After an initial failure he managed to induce an increase in the plasma cell population in the animals' bone marrow. This increase was accompanied by anaphylactic shock (a sort of allergic reaction) and Kolouch was not sure whether the increase in plasma cells was simply a secondary response. Neverless, he published a short note—in 1938—suggesting that plasma cells may be implicated in antibody formation during infections.

It was by helping Kolouch sort out some proper controls that Good first got involved in immunology—he was now doing "something important". This was Good's first encounter with an experiment of nature—seeing a high level of plasma cells in a fatal infection. He analysed it in the laboratory by inducing passive anaphylaxis in rabbits and discovered that the plasma cell level remained normal. Here then was good evidence that plasma cells are involved in the immune response to infection.

By 1949 Good had graduated from medical school and had completed house-officer training as a paediatrician. Meanwhile his dual life as a researcher and doctor continued and he had become an established "plasma cell hunter". Good was studying rheumatic fever in children and he noticed that as the disease progressed the level of gammaglobulin (protein antibodies) in the blood increased. In parallel with this he saw a build up in the population of plasma cells—here was more evidence linking antibody production to plasma cells. In 1949 Good was invited to the Rockefeller University, New York, to do a one year research fellowship with Maclyn MaCarty. It was while he was at the Rockefeller for that year that Good developed a deep love for New York, an affection that played a large part in persuading him eventually to break his long association with the University of Minnesota.

During his year at the Rockefeller, Good met Henry Kunkel, a man "with a fire in his belly". Kunkel wanted to get access to some myeloma patients (who have a tumour of the plasma cell system) so he could study the protein products of the plasma cells. Of course, as an indoctrinated plasma cell hunter, Good was just the man to help out Kunkel with his problem. So by one of those quirks of fate the right two men came together in the same place at the same time. And from their brief association sprang all the work that eventually was to lead to the detailed molecular description of protein antibodies that earned Gerry Edelman (of the Rockefeller University) and Rodney Porter (of Oxford) joint shares in last year's Nobel Prize for medicine.

The discovery of antibody structure began with Good drawing samples of blood from myeloma patients and Kunkel isolating the gammaglobulins and doing beautiful immunochemical analysis of these proteins. As it turned out, both men were to learn a lot from the experiment, but in very different ways. Kunkel found that plasma cells manufactured a whole series of proteins that were quite definitely distinct from each other, but nevertheless were closely related. This, of course, turned out to be the large family of protein antibodies with which we are so familiar today. While Kunkel was "opening the Pandora's box", Good was learning a great deal simply by talking to his patients, something he had to do because he was sticking needles into their arms to get blood, but also something he always makes a point of doing anyway.

While he was talking to his myeloma patients Good learned that they had severe problems with infection. This puzzled him because he knew the patients had lots of plasma cells (and therefore antibody) in their blood. Plasma cells are designed to fight infection, so why did these patients have more than their fair share of infections? (Remember, the twin arms of the immune system were nowhere in sight in 1949.)

Problems with infections

Meanwhile, Good was doing what he considered was a rather pedestrian job that he thought would please his boss McCarty. Some time earlier McCarty had crystallised a so-called C-reactive protein, a protein that appears at the beginning of acute infection and disappears later on. Good went in search of a suitable source, which turned out to be Hodgkin's disease patients (this is a tumour of certain lymph nodes, which are part of the immune system). Once again Good came into close contact with patients while he was collecting samples for McCarty to analyse. And once again he discovered that these patients also had problems with infections, but they were different from the myeloma patients. People with Hodgkin's disease were particularly susceptible to low grade infections whereas myeloma was associated with a vulnerability to high grade pathogens. What could it mean? Good also got the idea that hypersensitivity (which we now know to involve cellular immunity) was not linked to antibody production. In retrospect these were the first glimmerings of the now well established dual immune systems. But at the time—1950—"it was all very confusing." "It was simply a clinical observation", Good now says, "but it was certainly a thorn in my side."

When he went back to Minnesota—in 1950—Good was joined by Lewis Thomas, who is now the new president of the Memorial Sloan Kettering Cancer Centre. By 1952 they were doing what turned out to be important work on agammaglobulinaemia (no antibodies in the blood), though they didn't recognise it at the time. Good had some patients who were extraordinarily susceptible to infections, so he was looking at their white blood cells to try to find out why. The clue came when Ogden Bruton published a paper in the Paediatric Journal describing a boy in Virginia who was unable to defend himself against high grade pathogens. This boy had no plasma cells and very little gammaglobulin in his blood. Good immediately

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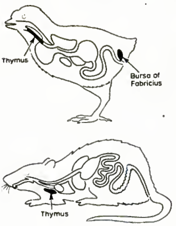

looked at his own patients and found they were just like Bruton's—they also lacked plasma cells.

More pointers to the dual immune system came when Good discovered that these agammaglobulinaemic patients were quite capable of developing delayed type hypersensitivity reactions and could also reject foreign skin grafts (both of these are mediated mainly by the cellular immune system). "But it was all still a great haze and I didn't begin to express the ideas about two systems clearly until three years later (1955)."

Yet another experiment of nature presented itself in 1952. One of the patients Good studied with Richard Varco had broad-based immunodeficiency together with a large tumour of the thymus gland (which is just behind the breast bone). This prompted him to wonder—as other people had—what role the thymus gland might play in immunity. Having been presented with a model by nature, Good tried to simulate it in the research laboratory. He took out the thymus from four-week-old rabbits to see if it affected the animals' immune competence. It didn't do a thing. Good was very puzzled. But he was so convinced that there must be something important in the clinical observation that he wrote a paper saying that the experiment of nature must be significant and that the laboratory experiment must be at fault.

Good had to wait until 1959 before he got any real clue about what it all meant. But because of the perhaps understandable lack of judgment of the prestigious American journal, Science, the clue had languished unheeded in an obscure back alley of the scientific press. In the mid 1950s Bruce Glick, a graduate student at Ohio State University, was trying to discover the function of a tiny gland—the bursa of Fabricius; see Figure 2—at the end of the chick's alimentary canal. Glick's teacher had told him that if he could discover what the gland did he would be a famous man. Glick removed the bursa from chicks of all ages and observed them to see what effect it had. As far as he could see nothing happened. He wasn't getting anywhere. Meanwhile he was supposed to be teaching a short course of the immune response, but because he'd already done it once he sloughed the job to Timothy Chang, another graduate student.

While he was preparing the class demonstration Chang made the mistake of using a chick that had been bursectomised immediately after hatching; he thought it was a normal bird. To his great embarrassment he was unable to induce an immune response in the class demonstration. But Glick was delighted because he now had a function for his pet gland—it must be involved in immunity. They tried to get the observation published in Science, but the journal dismissed it as "being of no general interest". Much discouraged, he got it published in Poultry Science where it lay unnoticed for several years until Harold Wolff, a friend of Good's, came across it in 1959.

Wolff had developed elegant techniques

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for measuring protein in chicken blood. So he applied his methods to a chick bursectomised at hatching and discovered that the antibody level was disastrously low. He told Good who became very excited about it all. "It was a bolt out of the blue," Good says. The excitement in the Minnesota lab was tremendous. If the bursa has to be removed at hatching to have any effect on immunity the thymus might have to be removed immediately after birth. Was this what was wrong with the previous thymectomy experiments all those years before? To check they thymectomised "hot little newborn rabbits". It worked. The animals' immune response was blunted and in a very selected way. Thymectomised rabbits could manufacture some antibodies pretty well, but they were unable to reject foreign grafts or develop delayed type hypersensitivity reactions. So here then was a really good demonstration of the dual systems of immunity at last.

By one of those uncanny coincidences that so often occur in research, at least three and possibly four groups all lit upon the importance of the thymus roughly at the same time. Jaque Miller at the Chester Beatty Research Institute in London, came up with the same conclusion as Good, but from an entirely different direction. Macfarlane Burnett's group in Australia and Waksman's group at Harvard were also on to it.

Although the haze was beginning to lift from the dual nature of the immune system, it was by no means completely cleared. Good decided to concentrate on chicks for a bit because the two central lymphoid systems were readily accessible there. By 1965 he had learnt a lot. The bursa is needed for the development of germinal centres in lymph nodes that give rise to plasma cells and one population of lymphocytes, both of which can produce antibodies. The thymus, on the other hand, is responsible for generating a population of lymphocytes which mediate the cellular response (see Figure 1). Max Cooper, a colleague of Good's presented all this at a clinical meeting in 1965. He said the agammaglobulinaemia patients are just like bursectomised animals. Immediately a man ran from his seat to the microphone and shouted "that's it; that's exactly what we've been seeing in Philadelphia". The man, Angello Di George, was working with children who lacked thymuses. He knew they had plenty of antibodies, but they still couldn't live. The reason was now obvious to him—they lacked the cellular arm of the immune defence.

Gradually immunologists were beginning to dissect the defence system and could contemplate selective repairs in patients with certain types of immunodeficiencies. At a conference in 1967 on immunodeficiencies the participants decided that there ought to be two procedures for correcting deficiencies: thymus transplant for Di George type patients, and bone marrow transplant for combined immunodeficiency. Bill Cleveland of Miami succeeded in curing the cellular immunodeficiency by transplanting foetal thymus membranes into a patient with Di George's syndrome. Good and his colleagues tried the bone marrow transplant, but ran into difficulties.

The first bone marrow transplant Good tried was on a little boy dying of combined immunodeficiency; he couldn't defend himself against any sort of infection. The Minnesota team used foetal liver as a substitute for bone marrow, and did a thymus transplant as well. The immune system was repaired perfectly but the boy died because the graft had attacked the host tissues—a graft-versus-host reaction. Good was extremely discouraged by this failure. But sitting half dozing one night—"I become a pumpkin about 11.30"—the answer suddenly came to him. It was 1.20 am when Good rushed to the telephone to tell his colleagues Dick Hong and Ed Yunis. They were sure he was right. Good was so confident that with Hong he wrote a paper telling everyone how to do it. The trick, he guessed, was to match donor and recipient with respect to their major histocompatibility components.

A few months later a suitable case arrived, the procedure was carried out, and the patient was cured. "It's like creating life," Good says with obvious feelings of excitement and awe. That patient is now five years old and is living normally with his sister's immunity and her blood group.

Good is now trying to dissect out the molecular components of the immune system. He's not daunted by this challenge because he places great faith in the powerful analytical techniques that are now available. "It took Stein and Moore longer than 10 years in the 1950s to get an amino acid sequence of a protein; it now takes 70 minutes. With the sort of methodology we have today the word factor is obsolete. You can now characterise and quantify substances very rapidly. This is part of a great scientific revolution." He wants to apply this methodology to the immune system and also to cancer—two very closely linked phenomena.

Patients with primary immunodeficiencies have a much higher than normal cancer rate: 150 in 2000 rather than 7 in 100 000. But it is not a general increase in cancer; there are certain types that are more common. What does this mean? Good is not sure yet, but he's certain that studying the immune system is going to teach him a lot about cancer. And cancer is going to reveal how normal cells work too. Cancer cells don't respond to the signals so important in third biological language, and that should help us discover what the normal language is. The first language is the genetic code; the second is the sort of molecular recognition one sees between enzyme and substrate and antigen and antibody; and the third is the way cells communicate at their surface. "It all has to do with molecular patterns at the cell surface, and I'm going to find out what it means".

The day I met Good he was due to see the first patients in his newly established immunodeficiency clinic in the Memorial Hospital. He's a man who cares about his patients and wants to help them; in return he wants them to help him, because like Kunkel back in 1949, Good has a fire in his belly too.

Technology review

Still searching for a European industry base

Recent decisions (or lack of them) by the European Commission throw doubt on the feasibility of the grandiose "European industrial base"—particularly in high technology industries.

In October last year the Prime Ministers of Britain, Denmark and Ireland met in a summit conference in Paris. They laid down guidelines which would "by the end of the decade transform the whole complex of their relations into a European union". For industry this was said to require the creation of a single industrial base which involved the elimination of all technical, fiscal and legal barriers to trade; adoption of a European company statute; opening up of public sector purchases and the promotion, on a European scale, of competitive firms in the field of advanced technology.

Everything that has happened since suggests that either the Prime Ministers did not really think through the true nature of the policies to which they had committed themselves; or, if they had, they were not entirely sincere in their commitment.

Thus, two weeks ago in Brussels the Dane, Olav Gundelch, the Commissioner responsible for the internal market, pointed out that the abolition of internal tariffs had not in fact resulted in an effective opening up of frontiers. Customs procedures and formalities, differing public health laws and quality criteria, as well as fiscal and other structural differences, all combined to prevent the free flow of goods and the formation of companies taking advantage of a Europe-wide market.

In the more important area of advanced technology, still less is being done to create a European industrial base. On the contrary, the suspicion is gaining ground in Brussels that the Council of Ministers is deliberately avoiding taking a decision on the "Memorandum on the Technological and Industrial Policy Programme" put forward by Altiero Spinelli, the Commissioner for industry and technology.

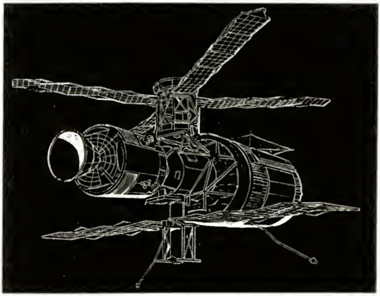
Roughly speaking, Spinelli is anxious to move the Community towards a Commission-monitored environment in which the public purchasing policies of member states would be open to all without national preference. The formation of transnational European companies would be encouraged and the Community would be able to finance, from its own resources, industrial development contracts open to all European industry.

He has been trying, so far in vain, to get the Council to discuss the Memorandum, itself based upon the programme drawn up some years ago. Such a discussion would reveal the real political inclination and attitudes of member states, instead of the fulsome and wordy declarations of summit communiques.

All the signs are that member states will dodge the real issues and play for time. In fact, it is quite clear from other developments that the trend is *away* from the creation of a European industrial base—If Europe means EEC and non-American. To take but two examples. The Commission is still having difficulty deciding a policy for the European computer industry. It is believed that Spinelli is isolated in the Commission, with his fellow Commissioners taking the line that there is no future in trying to set up two European computer companies (two would be in accordance with the Community's competition policy). Some powerful voices can be heard urging mergers with American companies.

The history of the Commission's proposals for multinational corporations is indicative of the same trend. A document on the subject has been oscillating to and fro for about two years and was finally discussed at a meeting last week attended by all the interested Directorates General of the Commission — Social Policy, Regional Policy, Environment, Science, and Competition as well as Industrial. No agreement was reached. Differences include such basic issues as shareholding in American multinationals and what should be the role of the Community (and, in particular, the Commission) as the political power opposed to the economic power of the multinationals.

In retrospect it appears that the call for a European industrial base was rather too glibly made: it will be necessary in the near future to think the consequences through.



Instant power for Skylab — but at a cost

Scientists and engineers working on America's space programme are trying hard to show that there really is some life in the programme. Following the partial failure of Skylab's power system (see New Scientist, 31 May, p 547), engineers at the United States National Aeronautics and Space Administration (NASA) are now preparing an auxiliary supply system that can be sent into orbit with the fourth Skylab mission.

According to last week's issue of Aviation Week (2 July, p 49), the North American Aerospace Group of Rockwell International is building a Skylab solar array module (SAM). This is an aluminium cylinder about four metres long, to which will be attached two panels of solar cells identical to those used in the Skylab solar "windmill". The unit, which will be manually controlled, can deliver 2000 watts of power.

NASA will not decide whether it will launch the SAM unit until the last minute (and even if launched SAM may not be used). If nothing goes wrong with Skylab's existing power supplies, there should be enough power for both of the manned flights due to visit the space laboratory. The next three-man mission is now scheduled for launch on 28 July, and the final mission for November.

A factor against SAM is that, once docked onto Skylab (see illustration above) it would block some of the Earth resources sensors. The view from four multispectral cameras would be entirely obliterated.

It is costing NASA between \$2·5 and \$3 million to build the auxiliary unit. The cost of the extra equipment can be absorbed into the Skylab budget because Skylab has not cost quite as much as NASA thought. At the same time, it can save money by sending the final crew up early. As a last resort, it can save a million dollars a day by curtailing the final mission.

Shell spills some LNG

Oil spills are bad enough, but a liquid natural gas (LNG) spill might be catastrophic, or at least very explosive. With the increasing transport of LNG around the world in large tankers, even the oil companies are getting worried that they do not know quite what would happen in case of an accident. Last week Shell International Petroleum quietly, and successfully, dumped some LNG into the Bay of Biscay just to see what happens.

LNG is more than 90 per cent methane, with a boiling temperature of −162°C. Upon impact with sea-water it vapourises with almost explosive force. Calculations by US investigators, published in Environment (November 1972), indicate that a spill of 1000 cubic metres of LNG would evaporate in 1·8 minutes, forming after 15 minutes a low-lying cloud of cold, dense vapour nearly 1·3 km in radius. It need hardly be added that methane vapour's commercial value depends on its ready inflammability.

Shell used the new LNG tanker Gadila, the second of seven doubled-hulled Shell vessels which will carry LNG from Brunei to Japan under a 20-year contract. The series of test spills took place on 3 July about 80 km off St Nazaire, where the Gadila was built. The Gadila has a capacity of 75 000 cubic metres, equivalent in size to a 100 000-ton oil tanker.

LNG was spilled with the ship under way at varying speeds and also with the ship stationary. The sea was calm, with a wind of about 6 knots. Film was taken of the spill and of the resulting gas cloud, from two helicopters and a tug. The results of the tests are now being evaluated.

The brief Shell press release announcing completion of the tests observes: "Should, however, the gas cloud envelop the ship then there is a risk of fire and it is hoped, as a result of the tests, to give guidance to ships' masters on the minimum wind or ships' movement necessary before the gas can be released." Presumably the guidance will include suggestions that masters of LNG tankers avoid running aground in a flat calm.

Household rubbish recycler a year away

A new process for distilling high-calorific gas and valuable oils from ordinary household rubbish is now close to becoming commercial, according to the Warren Spring Laboratory. Valuable metals and low grade solid fuel can also be extracted in the process. Because the metals are not oxidised, the char containing them is easily crumbled so extraction is simple.

The process was one of several shining household refuse has been a problem. But Warren Spring has now developed two effective ways of getting the heat into the rubbish where it is needed. One is to sprinkle the rubbish with re-usable steel balls about an inch in diameter to provide conductors, and then to heat up the rubbish with inductance coils. The other involves recycling some of the hot gases distilled off through the plant. Each method heats up the rubbish about 12 times faster than previously, and, with support from the Department of the Environment, prototypes of each are now being tested. Within six months the best method will be selected and a full-scale pilot plant will be built. The first commercial plant is firmly scheduled to be built in a year's time.

The process was one of several shining examples of new developments in recycling shown at the Design Centre last week, as a curtain-raiser to a Design Council exhibition on the re-use of waste products (1-27 August).

The world's first plant able to recycle mixtures of plastics containing high levels of commonly found impurities (including metals) will also be on display at the Design Centre. A strong, light, waterproof material resembling chipboard is the end product. The Regal convertor, developed with the support of the National Research Development Corporation, turns plastic waste into small chips, and feeds these into a convertor. This heats and compresses the chips into sheet from which a variety of products can be moulded. By squirting coloured plastic out of a second or third feeder nozzle, the sheet can be coloured on one or both sides. Products already being made in this way include industrial pallets and corrugated roofing sheets.

Also on display will be a compact plant (a 2ft cube) for extracting silver from photoprocessing solutions. Silver is extracted by electroplating it onto a cathode which can be taken out and cleaned at intervals. Photographic bleach solution treated in this way can be re-used many times. The potential for such a simple and fully automated process is very large—the United States photographic industry alone uses about £100 million of silver per annum. And the price of silver—now £1 per ounce—is twice what it was about a year ago. Typically, the new plant is said to pay for its installation costs within 40 days, extracting £75 worth of 99 per cent pure silver from 1000 litres of effluent.

Avalanche diodes poised for 50 GHz

The use of semiconductor power amplifier and oscillator elements for long haul centimetric and millimetric transmission now looks one step nearer.

Philips Research has announced that the Laboratoires d'Electronique et de Physique Appliquée have developed gallium arsenide avalanche diodes with efficiencies approaching 20 per cent at centimetric wavelengths. The more usual range of efficiencies is up to about 3 per cent which has limited applications.

The increase in efficiency puts the new diodes close to the performance of travelling wave tubes (twts) for use as repeater amplifiers in microwave relay stations, and with further development should make it possible to replace twts altogether. The French laboratory is convinced that usable efficiencies at 50 and even 100 GHz are just around the corner.

At present the use of avalanche diodes has been confined to low power microwave applications such as local oscillators in microwave receivers, and for very short range radar, particularly the sort used in burglar alarms. For these applications power of a few milliwatts is sufficient. If the semiconductor device can be substituted for twts this should bring the same kind of advantages as the transistor brought to electronic equipment—namely cheapness, reliability and portability.

The gallium arsenide avalanche diode is fundamentally a reverse biassed pn junction which produces negative resistance. It does this by generating a 90° phase lag between current and voltage at the junction. The length of the depletion zone is tailored so that the time taken by charge carriers to cross it increases this lag to 180° (negative resistance).

The device produced in France can be operated in either the oscillator or the amplifier mode. In microwave relay stations it could be used in either mode depending on the nature of the signals being handled. It can be used to amplify microwave signals directly, though in practice this would not be done because of relatively high noise. Instead a first stage amplifier would be tied in the circuit. In the oscillator mode pulse-coded signals can be amplified by injecting incoming signals to synchronise the oscillator which provides output.

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New electronic gadgets for the police

The Carnahan Conference on Electronic Crime Countermeasures is held annually at the University of Kentucky to let the military-industrial complex promote their latest goodies to the police. Many of the items have been tried out in Vietnam, especially as part of the electronic battlefield programme, and the conference provides a revealing glimpse of the state of military and police electronics. These items are from this years conference in Kentucky. The University of Kentucky will also be running the First International Conference on Electronic Crime Countermeasures at the University of Edinburgh next week.

US Army designs impenetrable room

Based on its "considerable expertise in the development of tactical sensors for Southeast Asia," the US Army Mobility Equipment R & D Center was asked to develop the best possible intrusion detection system with commercially available components. The resulting integrated system was described to the conference by Ben C. Barker.

Four kinds of penetration sensors are combined to give a first line of defence. A balanced magnetic switch is attached to doors and the like, with a magnet on the door and a switch on the frame. When the door is closed, the field from the magnet combines with a second field inside the switch to produce a new field. If the door is opened, this new field is changed, triggering an alarm.

Second is a vibration sensor attached to metal barriers such as screens or window shutters. Tests by the US National Bureau of Standards showed that normal vibrations exceed attack vibrations at most frequencies. However, between 2 kHz and 4 kHz and between 10 kHz and 15 kHz normal vibrations are surprisingly low. Therefore, the vibration sensor works in one of these ranges (the higher one).

An alternative method of entry would be drilling through a wall, so the third sensor, attached to walls, monitors the 20 kHz to 30 kHz range to detect the sound of saws, hammers, etc against hard materials.

If the villain still gets through the wall, the fourth penetration sensor is a 10 cm square grid of wires stapled to the inside of the wall which triggers an alarm if broken.

Once inside, the intruder must face a doppler shift based ultrasonic motion sensor. This device radiates a sound "well above the audible range" and looks for returns of a slightly different frequency caused by moving objects. "The unit will easily discriminate a moving intruder from air turbulence, blowing curtains, vibrating walls, doors, etc," according to Barker.

Finally when the intruder attempts to tamper with valuable objects, special sensors can be employed. A magnetic loop will detect the removal of metal objects such as guns. And capacitance proximity sensors will detect any change in the electrical connection between a metal object, such as a safe, and the ground that might be caused by a person. The sensors are now so good that they will sound the alarm if a human gets within 3 mm of an object.

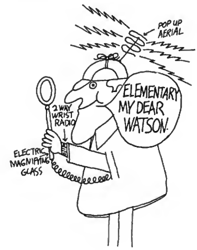
Naturally, the whole system will have microphones so that the surveillance command centre can listen in on intruders. But to "prevent monitoring of conversations within the protected area during normal access periods," Barker promises that the microphones will be turned on only if one of the other sensors is triggered.

Keeping guns off aircraft

When the gunman says "I'll fill you full of lead," he is right—bullets are made of lead. General Electric (US) and Westinghouse propose to use this fact to detect guns in airline baggage, a problem that concerned more conference speakers than any other.

The GE method is based on the fact that lead reradiates X-rays at exactly 74 keV. Exposing the baggage to low level X-rays and looking for this emission works well. The one problem is that electrical solder also contains lead, so that transistor radios would trigger an alarm. But solder contains tin as well, which reradiates at 25 keV, so a double detector is proposed that sounds the alarm for lead but not tin and lead. GE reports that the device would detect loaded guns, bullets, and explosive detonators, but not unloaded guns, if each piece of baggage is exposed for only 6 seconds on a conveyor.

Westinghouse uses very high voltage X-rays—at least 240 keV—which are not absorbed by other metal objects but which are absorbed by lead. Then all that is needed is an array of detectors that sound an alarm if the X-ray source is ever blocked by passing baggage.



Beating radio-equipped criminals

"The Watts riots were known to be directed by radio and several other public disturbances are known or suspected to have been controlled by radio from a remote location," according to Rober Pfister of the Watkins-Johnson Company of Rockville, Maryland. Bugging represents another illegal use of radio.

The military, he said, has long had electronic counter measures (ECM) to monitor and "ferret out these illegal devices" but they have only recently become available to the police (from companies such as Watkins-Johnson).

The problem is that the police broadcast on frequencies assigned by the US Federal Communications Commission and which are publically known, so that criminals can listen to the police. The criminals, on the other hand, are not restricted to frequency and thus are more difficult to detect. But receivers now exist which will cover the entire radio range from 1 kHz up to 40 GHz and which will also permit the user to tune in to a specific frequency. One Watkins-Johnson device has a display which shows all frequencies between 2 and 1000 MHz that are being used for broadcasting.

Oxygen blocks radio snoopers

Radio signals exactly the frequency absorbed by the oxygen in the air should have special advantages for law enforcement applications, according to three speakers from the Aerospace Corporation, Los Angeles.

Oxygen molecules in the air have a set of closely spaced resonances in the narrow band from 57 to 63 GHz. This means that a radio signal at 60 GHz (5 mm wavelength) is attenuated by 16 dB/km, nearly 100 times more than signals at, for example, 30 and 120 GHz. This has the advantage that it virtually eliminates the possibility of anyone else listening in, and it can also eliminate electromagnetic interference. Other advantages are small antennas, wide bandwidth, small power requirements, and extant technology. Not only could normal police communication use this frequency, but also the special radio signals used to change traffic signals for emergency vehicles.

Neither VHF nor optical signals have been successful for this latter application.

Healthy noises from European computing

Four of the major European computer companies ran signals up flagpoles last week to indicate that all was well.

ICL announced that its interim reported profit figure was in line with previous forecasts; at the same time the government announced that it was boosting its current support funding for the 1972 to 1976 period from £14 million up to £40 million. ICL's projections indicate that after 1976 the need for support will disappear.

On the same day the Siemens, Philips, CII joint venture in European computing was launched under the name of Unidata. The firm will cover not only medium and large computers, but will also market minicomputers and small visible record machines. The final agreement, therefore, represents something of a triumph for Philips who have had their experience in ledger keeping computers enshrined in the new firm's range (thus keeping Nixdorf at bay) and have forced CII to withdraw its objections to including minicomputers in the combined offerings from Unidata. Special purpose machines are still excluded from Unidata's range so each participant is free to dabble in telephone exchange computers and the like.

Unidata and ICL are pursuing different technical ideas at the moment: Unidata will keep close to the IBM patterns of computer design, while ICL is concentrating on new styles of machine architecture. But these short term differences are more apparent than real. Technology is offering a number of alternative ways of bringing different computing styles together in about five years. Burroughs already claims to have created a chameleon computer, the B 1700 (New Scientist, vol 58, p 683), that will act as a shell to house any style of machine. Currently, Burroughs are aiming at IBM's small machines.

On the other hand, the large users of computers are heading towards the notion of buying complete business operational systems which involve manufacturers in taking some special responsibility for the continuity of such systems over a long period of development. ICL are doing this by putting various software ideas into operation while Unidata will offer a parallel continuity to products from IBM. Since IBM is thought to be going to offer a more varied diet for computer users in three years or so, it seems that Unidata's final options will be at least as varied as ICL's by 1976.

ICL is researching variable computer units like the B 1700 and also studying the hardware aids to running data base operations for complete business systems. As a minor back-up, ICL is also looking at two ways of building big computers out of large numbers of inexpensive microcomputers. One, the array processor (New Scientist, vol 58, p 281), hooks small units in parallel so they all do the same thing. The other technique builds a range of machines out of building blocks, with different functions assigned to different blocks.

Suspensions to battle winds and corners

Two German companies—Honeywell GmbH and Daimler-Benz—have claimed patents for mechanisms to stabilise vehicles against wind and to compensate for cornering forces.

The Honeywell device is probably best suited to railway carriages. It consists of a strain gauge or pendulum mounted as an acceleration sensor at the centre of gravity of the vehicle. Sideways forces produced in fast cornering result in electrical signals from the sensor to a master controller which actuates hydraulic jacks on each side of the chassis. The jacks lift one side of the vehicle and so cancel out the transverse centrifugal forces which would otherwise threaten stability.

The Daimler-Benz system is a computer-controlled suspension for cars. Each wheel is independently suspended by a hydro-pneumatic unit consisting of spring leg and pressure reservoir. An analogue computer controls hydraulic switches between the reservoir and the leg, so that the amount of fluid in the leg can be regulated. Pulse transmitters mounted on the legs respond to movements and pressure variations in the suspending fluid and feed this information to the computer. This evaluates the pulses and passes compensating commands to the switches. Daimler-Benz claims the system could be effective in ironing out the effect of wind, poor road surface, torsional oscillation and shaking at resonant frequencies.

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Anti-science

There has been much debate about the uses and abuses of science, but little attention has been paid to the anti-science movement, which rejects science altogether and which may be a growing force in modern society

Professor Stephen Cotgrove
is at the School of Humanities and Social Sciences in the University of Bath

The debate about the uses and abuses of science is one which attracts widespread interest, and is not anti-science as such. More radical is the traditional Marxist concern with the need to harness science to the needs of "the people" and which, in its more sophisticated form, seeks to challenge the elitism of science. But what is given only scant attention by recent analysts is the growth of an anti-science movement which is more than a critique of the uses and abuses of science or the structural position and organisation of science in a capitalist society.

The primary preoccupation of the search for an "alternative" society in recent years has, of course, been its concern with exploring new forms of human freedom. Its thrust has been directed against the constraints of outworn institutions and ideas. But this has extended well beyond an attack on the rigidities of the technological society and the domination of the expert. Whether such ideas prove from the hindsight of history to have been prophetic or trivial is a matter for speculation. But the fact that they have caught the imagination, particularly of some of the well-educated young, indicates possible portents for the future. Moreover, it will be argued, the latent antagonism to science is sufficiently widespread that it cannot be dismissed as the aberration of a few hippies or reactionaries.

Much of the protest is, of course, critical of the uses of science rather than of science as such. Jeff Nuttall's book, Bomb Culture (Paladin, 1970), for example is written explicitly in the shadow of "the bomb". But the protest is more than a plea for a socially responsible science, harnessed to the promotion of human welfare. It is an attack on the technocratic society which is seen as the coldly rational and inhuman world of technology in which human ends are lost sight of in the search for rational techniques and bureaucratic efficiency.

Such an attack on the technological society is not confined simply or mainly to the outpourings of a literary and artistic underground. First published in France in the 1950s, Jacques Ellul's The Technological Society (Cape, 1965), mounted a powerful case against what he saw to be the domination of man by technique, of which technology in its narrower sense is but a part. More recently, the case has been further explored and reinforced by Herbert Marcuse (One Dimensional Man, Routledge, 1964) and Jurgen Habermas (Towards a Rational Society, Heinemann Educational, 1971). Technique, it is argued, comes to determine not only means, but also ends. Technique is the search for the one most efficient, right way. Hence there is no scope for human choice and judgment. Judgments about values are excluded not merely as non-scientific, but as unscientific, since they cannot be proved by any appeal to experimental data.

The attack on technology is not necessarily an attack on reason and rationality as such. Rather, it is an attack on the preoccupation in modern societies with technical means to the exclusion of human values and human ends. It is an attack on a society dominated by technique. But it is science which underpins technology and provides the fundamental knowledge for technological application. It is in this sense that science has become the contemporary ideology — the justification and legitimation for the technological society and above all for the technocrats who have become its chief functionaries. A technocracy, argues Theodore Roszak in The Making of a Counter-culture (Faber, 1968), is "a society in which those who govern justify themselves by appeal to scientific forms of knowledge. And beyond the authority of science there is no appeal." Science itself then comes to be seen as part of the apparatus of domination; the justification for techniques and technologies which are imposed without consideration for other human values.

It is this aspect of science which inspired the invective of the literary and artistic underground in the 1960s and has been a dominant theme in the widespread student protest. In its most extreme forms, this condemnation of science as cold, calculating and inhuman slides into an attack on reason itself. This is more than an affirmation of imagination and spontaneity. It is more than an assertion of human warmth and community against the cold impersonality of rational, technical and bureaucratic efficiency. Society is seen as itself irrational in the sense that there is no reasonable relationship between society and the nature of man. The old liberal view of a rational and humane society is found to be bankrupt. Reason is rejected because it has failed. The vision of the new and original world can only be achieved by violent assaults on the imagination, including the use of drugs which blow the mind and provide release from the constraints and limitations of ratiocination. In Nuttall's phrase, "the root of political development is creative and irrational".

Anti-authority

Not only the thematic analysis of contemporary literature but also more rigorous researches suggest that the search for new forms of freedom and the attack on science and reason are related. As long ago as 1938, the psychologist Jaensch claimed to have discovered a type of personality which he described as characterised by liberal views, taking pleasure in eccentricity, individualistic, and effeminate. In the 1950s at Berkeley, researchers rediscovered a very similar authoritarian-liberal dimension of personality. Now what is interesting in this context is that both researchers discovered a type of person holding not only liberal views on a range of political and social issues but also characterised by a preference for more flexible and less structured patterns of thinking. In other words, their prefered modes of thinking were the opposite of the structured, authoritative, unambiguous, mathematically expressed styles which characterise scientific discourse.

More recently Kenneth Keniston, in a study of alienated students, identified a similar cluster of attitudes which included a conviction that the universe was unstructured and not governed by regular laws. Life is seen to be devoid of purpose; any meaning discovered is subjective, the future unpredictable, and the present overwhelmingly important. These students emphasise the value of passion and feeling; their main values are expressive or aesthetic. As their main aim is the development of awareness, anything "which might fetter or restrain their responsiveness and openness is opposed . . .". As students, "they are distinguished by their passionate concentration on a few topics of intense, personal concern". And, finally, their fantasy life is "rich, vivid, imaginative, anti-social, unconventional and sometimes bizarre".

Such a syndrome of liberal and anti-science views is not in fact confined to a small minority of extremists either on campuses or in the literary underground. In his study of sixth-form schoolboys, Liam Hudson (Frames of Mind, Methuen, 1968) found that the arts "divergers" were able to "think fluently and tangentially, without examining any one line of reasoning in detail", were "more tolerant of ambiguity" and exhibited "unbridled fantasy" and "capacity for the bizarre". What is particularly interesting, they were "much more likely to have views which are liberal and non-authoritarian". The anti-science syndrome cannot then be dismissed as the views of a small and extreme minority or inculcated by permissive universities. It is already articulated in the minds of a substantial proportion of the youthful population.

Explanations about this apparent linkage between anti-authoritarianism and anti-science views are inevitably speculative. There is nothing new, of course, about anti-science philosophies, of which Ellul, Marcuse and Habermas are but the most recent. A long tradition of romanticist and anti-rational philosophies celebrate the importance of instinct, emotion, imagination, spontaneity and community Indeed, such views reflect an optimistic view of human nature—the image of the noble savage.

The alternative and pessimistic view sees the need for external order and control to save man from his worst excesses. This is essentially the Hobbesian view of life in a state of nature as nasty, brutish and short. So it is possible to argue that there is a basic logical connectedness between those who seek to liberate and express the human spirit and opposition to limiting and restricting structures, including highly structured forms of thought. And science can be seen as an authoritative body of knowledge which structures both the beliefs and practices of its adherents in a way markedly similar to theology. The search then extends to ways of liberating the human mind and imagination from what are seen as the shackles of rigid modes of thought.

In short, it is being argued that there is more than one dimension to radical thought. The traditional Marxist/socialist/liberal critique has focused on the property institutions of society and the inequalities and exploitations to which these give rise; it is the uses and abuses of science on which it focuses. The conflicts between the various factions within the movement for a socially responsible science have been about how far science can be autonomous and neutral, and what should be its relations to society. Recipes vary from structural changes in society to new institutional forms for controlling science. All agree that science as such is potentially "a good thing". But it is the second major dimension of political debate which has come to the fore in recent years—the debate about order and freedom. The more extreme opponents of authority extend their critique to science, as antithetical to the values which they rate as most human. While the supporters of the British Society for Social Responsibility in Science are mainly academic scientists, "middle-class radicals" concerned with moralising science, the proponents of the counter-culture are non-scientists and anti-science. It is Marcuse not Marx who is their prophet. They too are mainly the well-educated sons and daughters of the middle-class. And they too are making a moral protest about society. But it is one which rejects science as fundamentally anti-human—even though, like Marcuse, they are often willing to accept such of its fruits as hi-fi amplifiers.

Future of science

There is the distinct possibility that the relative popularity of science in the post-war period may prove to have been its high point. Science has been espoused for its promise of material well-being, in short, for its uses. It is currently being criticised for its abuses. But not far below the surprisingly well-ordered and tidy surface of society there may well be rumblings of discontents and anxieties about society which science cannot meet, and which many scientists may find it difficult to understand.

The contemporary proliferation of cults and crusades, together with the renewed interest in mystical experiences, and a revival of belief in "spiritual" things among some of the thoughtful intelligent and well-educated young is one side of a coin which, from its other perspective, is both anti-science and anti-rational. The decline in institutionalised religion should not lull us into the belief that we are entering a new age of reason. Moreover, the divide between the two cultures is more than one of vocabulary: there are marked divergences of values which cannot be reconciled easily—the value of imagination, experience, spontaneity, community set against and contrasted with routinised objective research, authoritative knowledge, rule-governed procedures and the division of labour and specialisation which fragments social relations. The challenge to science is more than simply a question of harnessing science to socially responsible ends. It is a challenge to an intellectual enterprise which, to a vocal and perhaps prophetic minority, appears to be remote from human purposes and to be antithetical to many human values.

Just how widespread is the challenge and whether it will grow or diminish, we cannot say at present. But the 1971 OECD report, Science, Growth and Society, thought it sufficiently important to point out that "The world-wide culture of educated youth, which is deeply concerned with ecological perspectives and is increasingly anti-materialistic, egalitarian, anti-meritocratic, and anti-bureaucratic, could conceivably even adopt anti-rational views and could become more influential in the next decade than our extrapolations suggest . . ."

Such beliefs are most likely to gain acceptance if they resonate with experience. Much will depend therefore on the future direction of social change—on the extent to which rigid authoritarian "rational" bureaucratic structures are liberalised, governments adopt policies to tackle discrimination, deprivation and poverty, both nationally and internationally, technology becomes more sensitive to its unintended and deleterious consequences, and thus science is seen to be harnessed more purposefully to human needs. The OECD report is itself a testimony to the significant changes which seem to be taking place in ministerial thinking, which may presage a shift from economic growth as the overriding objective of advanced societies to a greater sensitivity to the quality of life. Moreover, there are faint signs of a shift towards more participative and less hierarchical structures in both sections of industry and some universities. Such changes could all blunt the sharpness of the attack on science and the technological society which it underpins. But this view is necessarily speculative, raises sociological issues of great complexity, and would not be shared by those such as Ellul who see little possibility of salvation from the inexorable march of technique.

What is clear is that the future of science cannot be divorced from its social context. Yet the majority of our science undergraduates continue to be educated in narrow honours schools, largely oblivious to the sword of Damocles which hangs over their heads, worried only about careers. Moreover, the study of the relations between science and society remains largely neglected in most universities (though there are notable exceptions), and is often too narrowly conceived as an exploration mainly of the impact of inventions and problems of policy. Without a much greater understanding of such relations, the future of science and technology, and of the societies which are so greatly influenced by them, must remain largely at the mercy of historical drift, short term exigent reactions to unforeseen crises, and possibly growing radical dissent.

Raindrops in satellite communications

In super-high-frequency digital communications, twice as much traffic is feasible on a given waveband by transmitting in two polarisation directions. This potentially great saving in satellite communications is, however, threatened by raindrop scattering effects. These are unimportant for spherical drops, but research has shown that cross-talk due to distorted drops depends on how much they are tilted

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Currently a new generation of telecommunications satellites is being planned which will be different in two important ways from those at present in service. First, the information as transmitted will be in digital rather than analogue form (allowing the transmission of pulse-code-modulated TV and telephone traffic); second, the radio frequencies used will be higher and as a result will be subject to degradation by scattering and absorption through rain and snow.

The radio spectrum below 10 GHz which is relatively free from rainfall effects has now been almost completely filled, hence the move to higher frequencies. Now that there is serious commercial interest in frequencies above 10 GHz, scientists and engineers are making every effort to characterise thoroughly the behaviour of radio waves at such frequencies in the lower atmosphere (an international conference on this subject was recently held at the Institute of Electrical Engineers). In the UK the major work in this direction is at the Post Office Research Department near Ipswich, and at the Radio and Space Research Station, Slough; there are also contributions from a few universities. A by-product of this research is a more thorough understanding and measurement of the structure of rainfall than meteorologists have hitherto required for weather forecasting.

That the higher microwave frequencies are attenuated (ie the power in a wave is progressively diminished) by rain and snow has been established since World War II. Moreover, applying classical scattering theory to groups of lossy dielectric spheres (raindrops) gave a reasonable explanation of the first-order effects of rainfall. At first, observers noticed significant descrepancies between theoretical predictions and measurements of attenuation versus rate of rainfall. But recent use of fast-response rain gauges, such as those developed by the Radio and Space Research Station, has shown that the discrepancies arose mainly from the measurement of rainfall rate rather than inadequate theory. Although earlier applications of

1

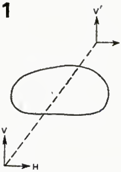

Figure 1 Vertically and horizontally polarised waves incident on a horizontal oblate spheroidal raindrop. The two polarisations V and H are attenuated on transmission, but their orientation remains unchanged

2

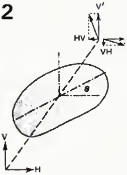

Figure 2 Vertically and horizontally polarised waves incident on an oblate spheroidal raindrop tilted through an angle θ°. This time the orientations of the two polarisations are changed, so that when resolved onto the original V and H axes, extra "cross polarisation" components HV and VH appear which would correspond to cross-talk in a radio system using two polarisations as separate channels

scattering theory to rainstorms gave a reasonable first-order prediction of rainfall attenuation, other effects remained enigmatic. For example, distortion of the wave polarisation was not explained until researchers more recently considered raindrops as slightly flattened spheroids.

To those not working in the field of radio propagation it might appear to be an academic question of the most remote type whether or not raindrops are truly spheroidal, or slightly distorted spheres. Yet a quantitative answer to this question is currently engaging many research workers throughout the world and may well be worth millions of pounds to the satellite communications industry.

To see the reason for the interest in the shape of raindrops, we must go back to the basic scattering problem. Scattering and absorption of radio waves by regular spheroidal raindrops would result in diminution of the total power in the wave as it propagates (ie attenuation), but would not significantly affect the polarisation of the wave (defined as the direction of the electric field associated with the wave). Propagation of waves through a group of small particles that do not possess complete spherical symmetry can, however, result in a change in the wave polarisation. To appreciate this effect we must briefly consider satellite telecommunications systems in more detail.

I mentioned at the outset that future telecommunications satellites will more than likely transmit digital information rather than analogue data. The adoption of digital modulation techniques gives improved reliability in multiple-section communication links of any kind. This reliability, though, is achieved at the expense of bandwidth unless very sophisticated techniques are used. Space on the radio-frequency spectrum is thus doubly at a premium: not only is the lack of it the motivation for moving into frequencies above 10 GHz; but it would also appear at first sight that modern communications techniques are going to use up the remainder of the radio spectrum at a higher rate per TV or telephone channel. However, the adoption of digital modulation methods has a built-in bonus for radio communications—the same frequency spectrum can be used twice on a single radio link by using two polarisations as separate communication channels. "Frequency re-use", as this technique is called, is not possible with most analogue signals since the cross-coupling between polarisations in a radio path is nearly always too high for such signals. On the other hand, a digitally modulated TV signal can operate with a signal-to-interference ratio as low as 12dB; signal-to-interference ratios of 18dB or more should allow satisfactory frequency re-use.

3

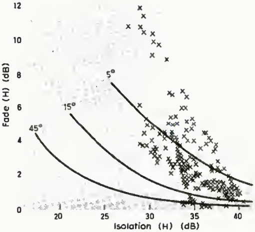

Figure 3 Measurements of cross polar isolation made during a typical heavy UK rainstorm. A horizontal polarisation was transmitted; vertical and horizontal polarisations were received. Graph shows fade experienced versus ratio of received power in the unwanted polarisation (in this case vertical) to that in the original polarisation in dB. (This ratio is the "cross polar" isolation.) Comparison of the measured points with the theoretical curves implies that raindrops are on average tilted at 10° or less

The importance of our distorted raindrops should now be obvious. If raindrops were perfect spheres very little polarisation distortion would occur and frequency re-use should plainly be possible. If raindrops are distorted to the extent that 1 per cent or more of the power in a wave with one polarisation ends up in an unwanted polarisation, then frequency re-use may not be possible. The capacity, and hence revenue of a digital satellite system will then be nearly halved.

The shape of raindrops is thus not of mere academic interest. It is well known that if we take a spherical water droplet and allow it to fall some 40 feet through still air under the influence of gravity the upward thrust of the air gives the overall shape shown in Figure 1. Application of classical scattering theory to raindrops of this shape tells us that the waves polarised along horizontal or vertical directions will still not suffer a change of polarisation. However, should the distorted raindrop be tilted, as it might be by wind (see Figure 2), then polarisations originally in horizontal or vertical directions will be changed and cross-talk between separately used polarisations would result.

Scattering theory predicts that the amount of cross-talk is critically dependent on the shape and orientation of the raindrops, about which we know only a little. Hence before frequency re-use can be exploited in satellite communication systems measurements (in rain) of cross-coupling between polarisations in rainfall must be made. Currently both ESRO and NASA are sponsoring measurements of rainfall cross-polarisation. Initial results are promising, provided that horizontal and vertical polarisations are used (as opposed to circular polarisation or any other orientation of linear polarisation). The scatter of the unwanted "cross" polarisation during a typical heavy rainstorm, measured by myself, is seen in Figure 3 to give cross-polarisation isolation ratios of greater than 25dB. This result implies that raindrops are tilted on average only slightly to the horizontal.

Certain engineering difficulties have to be surmounted before frequency re-use can be viable. Among them is the realisation of satellite-borne antennas with sufficient polarisation purity. Nevertheless, at present it seems likely that the slightly flattened raindrop is going to be sufficiently well-behaved to permit a saving of a few million pounds per satellite to the communications industry.

South Africa struggles to keep abreast

Last week's announcement that South African universities have withdrawn from the conference of the Association of Commonwealth Universities to be held in Edinburgh next month, illustrates the sort of difficulty increasingly experienced by South African educators. Contacts with the outside world are vital to the scientists and technologists but government policy makes it difficult

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The visitor to South Africa arrives with firm pre-conceptions about an economy built on cheap labour which are difficult to shake. Mine were shaken for the first time when I stood watching three black workers and a white supervisor replanting flowerbeds in Capetown's Botanical Gardens. The supervisor did not do a stroke of work. His three subordinates were so organised that each, in effect, was idle two thirds of the time. This was no isolated experience. One particularly striking demonstration of this principle was in an office where I saw a similar team at work. They took an hour and a half to repair one sash window.

Explanations come in many variations. Says one supervisor: "It's the only way to get any work out of the bastards." Another, less irrational: "Breaking up the job into simple operations and leaving them to do just that one thing does work; a multitude of functions confuses them." And the university lecturer, who describes himself as a liberal: "Theirs is a non-competitive society. The rules and considerations, moral or economic, of the white man's industrial society are simply not valid here."

One feels like saying that there seems to be nothing in the situation that proper education and training could not remedy. And, indeed, when one turns to the factory scene, where the low productivity of many South African outfits is a worrying feature, such thoughts are no longer anathema. A high flyer in the textile industry, who has found that on some of his machines the black worker's output is one third that of the white, has imported an ergonomics expert. "It is," he says, "more a question of finding out where the real talents of the black man lie and make more efficient use of them."

The thought, of course, is not new. Twenty years ago South Africa's Institute of Personnel Research devised a battery of tests to determine the trainability of illiterate Bantu labour. In recent years, with the increasing sophistication of the black worker, these tests had to be revised, and now modest beginnings have been made to study the Bantu's capacity of being trained to work with a background of automation. There is already a small project for training aids that would help him to learn to work with information rather than objects. And the government, now acutely conscious of the productivity problem, has appointed a committee which is looking into the question of training Bantus both before and during their employment. The intention is not only to raise the standard of the raw recruit, entering a factory, but, eventually, to smooth the way for him (trade unions permitting) to certain skilled jobs. Without some such move factories in the white areas will not be able to remedy their acute shortage of skilled labour, nor will the government's pet project—the setting up of border industries and industries in the homelands—ever get off the ground.

Whether these moves go far enough and are followed through fast enough to change the industrial climate remains to be seen. But where changes are now very much on the cards is in the field of science and technology. In his comfortable but unpretentious office in Pretoria, the scientific adviser to the Prime Minister, one time president of the CSIR, Dr S. Meiring Naudé explained:

"Until now anything that appeared of importance in principle was supported by the government; and the funds, once allocated, were, more or less, automatically renewed, the following year, plus a certain percentage added. In time this led to a completely unrealistic situation. It meant that the oldest scientific council, concerned with agriculture, was eventually getting 48 per cent of the total funds allocated by the government. There was much less for the latecomer and so, today, we have a situation where, for instance, metallurgy and mineral research, of tremendous importance to this country, is only getting 3 per cent of the total. The whole development, in fact, has been ad hoc. There has been no planning behind it, no priorities ever determined, no questions ever asked what you do with the funds, whether you are spending them correctly or not. In short, how much money you got depended greatly on how well you put your case."

French system preferred

Before deciding on how things should be changed Naudé travelled to France, Belgium, Holland, Norway, the UK, Canada and the US to see how this problem of funds and priorities was tackled by other countries. The French system, with its strong central control and its long-term planning appealed to him above all others and something akin to it is now being shaped in South Africa.

Circulars are being prepared which will soon go out to the various research departments asking them to specify exactly not only what they are doing at present but what projects they would like to tackle, on a three-year basis, provided they can get the extra funds. ("This", says Naudé, "will make them think ahead"). Once these programmes have been submitted, a coordinated national programme will be worked out to be eventually approved by the Scientific Advisory Council; and it is at this juncture that, as Naudé puts it, "the great breakthrough" has come. For it has now been accepted that the Prime Minister's Scientific Adviser (advised himself by 12 independent scientists) can advise the treasury directly on priorities, without going through the Scientific Advisory Council.

What then will the future look like? Naudé spells it out very clearly:

"We are convinced that a national programme of science must concentrate on what you have in the country. It is difficult to say how things will change, but I hope to convince the government that they should spend more than the present 0·49 per cent of the gross national product on research. If we could, say, spend another 0·1 per cent, this will amount to 10 million Rand, and with this we could certainly give our priorities a push in the right direction."

Not everybody likes what they see on the horizon. Many scientists see the new policy as a danger to fundamental research—a criticism of which Naudé is well aware but which he firmly refutes, pointing out, among other things, that even in the CSIR, designed for applied research, it has always been policy that every scientist should be allowed to spend one-third of his time on fundamental research. But this is not the only question raised. Another is where the scientific and technological manpower for expansion is to come from, in a country acutely short of such people, and which, as Naudé himself points out, has never succeeded in recruiting many productive scientists permanently.

One has, of course, heard of the existence of coloured universities and one wonders whether they could make some contribution towards easing this manpower problem. In time, possibly. But at present the consensus, including many who would receive non-white assistants with open arms, seems to be that, on the whole, they are not of a calibre to expect them to be productive in a research situation.

These plain facts on the manpower problem are easily established. But there are also more subtle factors that affect it. How many have asked the casual visitor about opportunities abroad — not for financial reasons but out of a sense of isolation, which seems to be far more widely spread than authority realises? It has its roots partly in geography—there is South Africa's distance from the technical and scientific centres of the rest of the world as well as the great distances within the country—but it also reflects the uneasiness of being associated with an embarrassing ideology.

Professor Naudé really does not acknowledge either of these factors. Though he hopes that more money will be made available to enable South African scientists to go abroad, he stresses that it has always been possible to send "the people with merit" every second year. And he is surprised to hear that South African scientists feel they suffer from political effects because "I have never experienced any political bias overseas."

One finds other scientists to have been less fortunate. There was the young lecturer, who went to the US to teach, and twice was refused accommodation by white Americans on ideological grounds; there was the professor at Capetown University who recalls how, on one occasion when he was associated with a number of foreign scientists for some time, one, deliberately and woundingly, refused to speak to him throughout this period. And there was that star of Capetown University, Professor Louis Ahrens—head of the university's geochemistry department, vice-president of the International Association for Geochemistry and Cosmochemistry, and leader of one of the first teams outside the US to be given an official role in the Apollo lunar research programme—still smarting from having been refused, not long ago, a visa to attend a congress in India.

The universities' future

How will the universities fare under the new policies? Naudé thinks the institutions could benefit and this may well be so, for under this new idea of priorities the CSIR could make out a good case for a particular project to be placed at a university and is very likely to obtain the required funds. Anything connected with metallurgy, for instance, or the human sciences (which Naudé also thinks have been neglected) may then stand a good chance. But what about the more esoteric type of work? What comes to mind, for example, is that admirable piece of research that culminated in 1965 in the observation of a neutrino, 10 000ft underground, in a mine turned laboratory, near Boksburg. It confirmed the existence of this particle predicted by Wolfgang Pauli a quarter of a century earlier. What was happening about further work? Professor Friedl Sellshop of Witwatersrand University says they are still waiting for funds.

There is another side to this, though. One comes across a great deal in universities and research institutes—some supported by industry—where one feels that perhaps a greater sense of direction and urgency is overdue. Is it not a bit long for the South African fruit export industry to have to wait 19 years for a new plum—even allowing for the fact that the breeding programme at the Institute of Food and Fruit Technology at Stellenbosch, where it was developed, was severely interrupted by a disease hitherto unknown in South Africa? And is it not surprising that in a country, where fish is economically so important, much of the know-how in this field is still being looked for abroad, and that includes fish farming. A visit to the Fishing Industry's Research Institute leaves the impression that too much is done on a shoestring—only one student, for instance, on a research project of great potential importance to South Africa's fish oil-and-meal industry — namely the better utilisation of fat in the lantern fish. And why does Capetown University still have no big department, with a big name at its head, to involve itself deeply in oceanography, a subject of such obvious importance to a country like South Africa? And this in spite of official encouragement in that direction.

Probably manpower shortage played some

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part in all these cases. It certainly will be one of Naudé's most difficult problems to tackle—perhaps his biggest, as it is, indeed, in the country as a whole. The insatiable appetite of a booming economy for more men in every field of endeavour is not readily appreciated. But what happens is well illustrated by the growth of CSIR alone. Its staff was fewer than 400 in 1952. Ten times as many were employed in 1971. And this picture is repeated in various ways throughout the economy, now committed to a real growth rate of 5·5 per cent annually.

What this means in terms of output from schools and universities is for the education authorities to solve and they know well that, in the long run, they cannot come up with an answer unless they can provide better training facilities for the black and coloured population on all levels. But the current climate of apartheid has room only for the most timid efforts. This is a dilemma where something, sooner or later, will have to give. The question is what and when?

Eclipse of the century

The total eclipse on 30 June was a record for our lifetime. Its duration will not be exceeded for the next 177 years. In this first-hand account an observer, who was present aboard a ship off the coast of Mauritania, describes the spectacular event and takes stock of eclipses in general

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On 30 June, thousands of astronomers gathered in parts of Africa to observe one of the longest total eclipses of the Sun to take place during our times. The track of totality—that is, the regions from which a total eclipse can be seen—started at local sunrise in Brazil and crossed Guyana, Surinam, the Atlantic Ocean, Santo Antao and Sao Vicente of the Cape Verde Islands, Mauritania, Mali, Algeria, Niger, Chad, the Central African Republic, Sudan, Uganda, Kenya and the Somali Republic, and ended at local sunset in the Indian Ocean between India and Madagascar. For about 2000 miles to either side of this track a partial eclipse was visible, the magnitude of the eclipse diminishing the farther the observer's distance from the total track. Beyond these limits no eclipse would be visible. The magnitude of a partial eclipse is the proportion of the Sun's diameter covered by the Moon; thus in an eclipse of magnitude 0·50, half the Sun's diameter would be obscured. The British Isles were outside the limit of eclipse, except to observers in the extreme south of England were a small partial eclipse was visible.

This particular eclipse was of special interest to astronomers because of its exceptionally long duration of totality. A total eclipse can never last for more than 7 minutes 40 seconds and the duration is usually much less—a five-minute eclipse would be considered to be very long. It is because the Moon's orbit is inclined to that of the Earth that eclipses do not happen at every New Moon. Usually the Moon passes above or below the Sun in the sky, but occasionally when all three bodies, Sun, Moon, and Earth are in a straight line the Sun is blotted out for a few moments and the glorious corona appears around its rim. The Sun is 400 times farther away than the Moon, but it is also 400 times larger, so that the two bodies appear almost the same size in the sky, and the Moon is just big enough to cover the Sun under certain conditions. The orbits of the Earth around the Sun and the Moon around the Earth are elliptical, and so at various eclipses the apparent sizes of the Sun and Moon can vary considerably depending on where the Earth and the Moon are in their orbits. For instance, when the Earth is at perihelion, nearest to the Sun, and the Moon is at apogee, farthest from the Earth, the Moon will appear too small to cover the Sun. A ring of sunlight will then remain around the Moon, producing an annular eclipse. Such eclipses are of no scientific value to astronomers since the corona does not appear. Nevertheless, they are interesting to watch.

For an eclipse with the Moon nearest the Earth and the Earth farthest from the Sun, the conditions will be reversed and the Moon will appear slightly larger than the Sun. Under these conditions, an eclipse of exceptional duration would take place, but only in equatorial regions at the end of June or beginning of July when the Earth is at aphelion. The Moon is at perigee once every month. Under these circumstances a 7 minute 40 second eclipse could take place, but would only happen once every several thousand years. Eclipses of the Sun (and those of the Moon) run in a series known as the "saros", a period of 18 years and 10 or 11 days, depending on the number of leap years between the dates. After this interval an eclipse will repeat itself with very minor differences, the main one being that the eclipse will take place about 120° west of its predecessor.

The period of the saros was known to the Babylonians, but it is still used today as the basis of eclipse predictions. There are three seven-minute eclipses this century and they all belong to the same saros series. The eclipse of 8 June 1937 was total for 7 minutes 4 seconds, but was exceeded on 20 June 1955 by one lasting for 7 minutes 8 seconds. This year's eclipse was total for 7 minutes 4 seconds and so the series has now passed its maximum and future eclipses will be shorter. For instance, the next eclipse in this series, on 11 July 1991, will last for 6 minutes 54 seconds. On each occasion the track of totality will move farther north until, after several hundred years, the track will move off the Earth's surface and the eclipses will become partial. Eventually, even the partial eclipses will move off the Earth and the series will be at an end.

Before the three seven-minute eclipses to take place this century, the previous eclipse to last for seven minutes occurred in the 11th century AD. The next seven-minute eclipse will be on 25 June 2150, when totality will last for 7 minutes 14 seconds, but unfortunately this exceptionally long eclipse will be visible only from the Pacific Ocean. Eighteen years later there will be an eclipse lasting for 7 minutes 26 seconds, and on 16 July, 2186 totality will last for 7 minutes 29 seconds —the longest eclipse to happen since the 8th century AD.

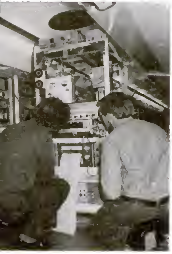
For this year's eclipse, I was fortunate enough to be on board the "Monte Umbe" a ship chartered specially for the eclipse to take members of the British Astronomical Association to a point in the track of totality off the coast of Mauritania in West Africa, where totality would last for 6 minutes 5 seconds. Our position was at latitude 19°38′ N, longitude 16°55′ W where excellent seeing conditions could be expected. Unfortunately, there was some haze which prevented us from seeing the outer corona. Nevertheless, it was a magnificent sight. No photographs of a total solar eclipse can give any idea of the atmosphere surrounding the event. As the magnitude of the partial phase reaches about 0·95, everything appears to be covered by a peculiar grey light. There is a considerable drop in temperature, and, about half a minute before totality, things become much darker, the air seems to be very still, the famous "diamond ring" appears followed by Baily's Beads, and just at the instant of totality the light fades completely, the corona appears, and the eclipse is total. The diamond ring and Baily's Beads are caused by the Sun shining through the valleys on the limb of the Moon. Baily's Beads are so called because they were first mentioned by the astronomer Baily during the eclipse in 1836. Although astronomers can carry out observations of the inner corona by means of a coronagraph when there is no eclipse, observations of the outer corona can only be undertaken during a total eclipse of the Sun. That is why astronomers are prepared to travel thousands of miles to see just a few minutes of totality.

French, British and American scientists flew in Concorde (see New Scientist, vol 58, p 9) from Las Palmas in the Canary Islands into the track of totality and kept the Sun completely hidden for over 70 minutes—more totality than the average astronomer can hope to see in a lifetime! On the morning of the eclipse, the decks of the Monte Umbe were alive with telescopes, cameras and all kinds of ingenious devices many of which had been built specially for the eclipse in order to record the brief moments of totality. On board ship, the main problem with observing the skies with telescopes or binoculars is the ship's movement. Most instruments set up on eclipse morning therefore had some counterbalancing device incorporated into their design to counteract the movement of the ship —for although we were anchored, any small roll of the ship would be greatly magnified with the aid of a telescope. Fortunately, though, on the morning of the eclipse, the sea was very calm and I am sure we could not have had better conditions as far as the setting up of our instruments on board ship was concerned. On land, it is estimated that 3000 astronomers set up their equipment at various places along the track, the main sites being Akjoujt and Atar in Mauritania where totality lasted 6 minutes, and Lake Rudolf in Kenya where the Sun would be hidden for about a minute less.

Apart from the astronomical experiments carried out during eclipses, ecologists and naturalists take advantage of these rare occasions to study their effect on the animal world. Birds and mammals start to bed down as the light dims with the approach of totality; flowers that close up at night do so during the total eclipse; and cocks have been known to crow at the end of totality, thinking that another day has dawned. Because the track of this year's eclipse passed over regions of Africa inhabited by primitive tribes, expeditions were sent to study the effect of the eclipse on such people whose daily lives are ruled by the stars. To most of these primitive people, the arrival of hundreds of scientists with no end of equipment can only mean that they have come to take the Sun away. That is exactly what members of the El Molo tribe, who inhabit the shores of Lake Rudolf, thought on 30 June when the Sun gradually disappeared. To these people, it meant the end of the world. Only when the Sun reappeared would they believe that all was well.

In time, every place in the world gets its turn at seeing a total eclipse. The figure is once in 360 years, but this is only an average and the interval between successive eclipses at any one place is by no means regular. For instance, since the year AD 600 there have been two total eclipses at London; one in 878 in the time of Alfred the Great, the other in 1715 during the reign of George I. Londoners will not see another for at least the next 500 years. The calculations required to determine when and where eclipses will be visible are extremely complicated. It was not until the 19th century, when the German astronomer Friedrich Bessel formulated his method for accurately determining the circumstances of eclipses, that we could pinpoint the tracks with any great deal of accuracy. Before that time, less sophisticated forms of calculation were in operation and it was not unusual for the predicted track to be in error by several miles. Disappointed astronomers, misled by inadequate mathematics, would await the eclipse only to find themselves outside the track of totality. With modern calculations, 10 years before the event, it is possible to plot the total track to within 10 yards.

I am sure that anyone who saw this year's eclipse will never forget it; how quickly the six minutes darkness passed; and the glorious diamond ring which appeared at the end of totality. After this, the Sun reappeared, the world re-awoke, and the great sight of 1973 was gone.



Equipment for studying the eclipse aboard Concorde. Essentially it is an extreme far-infrared interferometer to look at radiation from the Sun's chromosphere. It was designed by Dr J. E. Beckman of Queen Mary College, London

Will Sakharov soon be silenced?

There are ominous signs that the net is drawing closer, tighter around Academician Andrei Sakharov, so-called "father" of the Soviet H-bomb and the country's most eminent champion of human rights

Dr Sarah White

During the last few weeks Academician Andrei Sakharov's phone has been cut off several times during conversations with friends abroad—something which happened only occasionally before. There is also a report that one of his friends, already in prison, was questioned closely about Sakharov's activities. The interrogator mentioned that he had spoken with Sakharov and his wife and had noticed mental abnormalities in their behaviour. Both of these occurrences could be indications that the KGB is preparing a case against him.

Sakharov's own tactics over the past year have looked like those of a man who knew his time was running out. Just published in the Swedish newspaper Dagens Nyheter is a searing attack on Soviet society, which he made in a recent interview with Swedish television. The content is similar to a statement Sakharov made a year ago as a postscript to a memorandum he had sent to Leonid Brezhnev, though it is even more definitive in its criticisms. He attacks the anti-democratic nature of Soviet society, the hierarchic nature of the education and health services, excessive bureaucratisation and irrational administration, and the lack of freedom to travel both inside and out of the country "The Soviet Union has the same sort of problems as the capitalist world: criminality and alienation", he says. "The difference is that our society is an extreme case, with maximum lack of freedom, maximum ideological rigidity, and—this is most typical—with maximum pretentions about being the best society although it certainly is not that."

Coexistence and freedom

This is a far cry from the tone of his essay "Progress, coexistence and intellectual freedom", which first brought Sakharov to public attention in the West in 1968. In that document he discussed the dangers facing mankind—the bomb, hunger and overpopulation, pollution of the environment, and the narcotic of mass culture and bureaucratic dogmatism. The solution he saw was the possible convergence of socialism and capitalism. East and West must live together or perish. Though the document seemed initially to have been prepared for private circulation only, its tone suggested that the author felt its points could be the basis for some kind of discussion with even the Soviet government.

Sakharov's change of tactics must come from his experiences over the past few years with the "democratic" movement in the Soviet Union. He was one of the founders in 1970 of the Human Rights Committee formed to "search for constructive ways of securing human rights" in the Soviet Union. At that time it was said the committee would be strictly non-political and would act "in accordance with Soviet laws". The committee appeared in what might be called a heyday of human rights activity in the Soviet Union. Most important perhaps was the burgeoning of information through samizdat (self-publishing as opposed to the official state publishing) and the regular publication of the Chronicle of Current Events, which reported dissident activities from all over the Union.

Now the Chronicle has not appeared for nine months, many of the chief protagonists of the movement are either in exile abroad or detained in some way or another, and the government is in the middle of its biggest drive against internal dissent since the death of Stalin. It must be a period of acute depression for all those who participated in the human rights movement, who believed they could bring change by exerting pressure on the government.

Friendship treaties

For Sakharov it is a particularly tragic moment. The last year has seen the US-Soviet treaties of friendship—the coexistence of the two superpowers, one of the prerequisites for a sane world that he spelled out in his 1968 essay, is at present a reality. At the same time, his two other prerequisites, intellectual freedom and progress (for the whole of mankind) are still elusive ideals. Sakharov's work on the H-bomb naturally affected his social and political beliefs, as happened to scientists working in similar situations in the West. In the postscript to the Brezhnev memorandum, he mentions how he began his activities some 10 or 12 years previously (around 1960) "when I realise the criminal character of a possible thermo-nuclear war and of thermo-nuclear tests in the atmosphere". He is also concerned with the influence the military can have on a society. "Militarisation of the economy leaves a deep imprint on international and domestic policy; it leads to encroachment on democratic rights, the open conduct of public affairs, and the rule of law; it constitutes a threat to peace."

For the moment, however, it is Sakharov who is being threatened. In his recent interview he said that he does not fear for his own personal safety, but is afraid of pressure being put on his wife and family. In his own words: "That is the most terrible type of pressure and it is already at hand". His stepdaughter was expelled from Moscow University last year. The strategy of the state may be to depress and harass him so much that he decides to emigrate. That way, they lose a thorn in their flesh and avoid the international rumpus that any attempt to detain him would arouse. Leaving the country must go against his principles and wishes in many ways, but for Academician Andrei Sakharov there may be no other path.

Forum

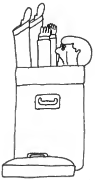
Westminster scene

Orfordmess

The House of Commons is an unpredictable place. By any ordinary reckoning, the case of the Orfordness Radar Station ought to have blown up into the most almighty scandal. The facts, as presented by the MP for Poplar, Ian Mikardo, many of whose fellow trade union members worked at the station, were devastating. He pointed out that economics Ministers have said that people should not be declared redundant without consultation and without the longest possible notice. How, he asked Minister of State for Defence Ian Gilmour, could an announcement at 2 o'clock on Friday afternoon be justified, to the effect that some hundreds of people, including 100 or so high-level scientists and technicians, would be cut out from work at midnight a day and a half later? Mr Gilmour is most adept at not trying to shine—which is perhaps wise for a Minister who is on a tricky pitch. He was superbly emollient. Of course, it was always a matter for regret when employees did not receive as much notice as they would like or expect. The United States government was anxious, for contractual reasons, to announce its decision before 30 June—and as it was by far the larger of the two parties, its view naturally prevailed. The future maintenance of the equipment was a matter for the US government.

For the Opposition Front Bench, John Morris, ex-Minister of Defence Equipment in the Labour government, wanted to know why a matter of this significance, on British soil, concerning British technicians, and some British money, should not have been the subject of a proper government statement? The staff had been shoddily treated. Gilmour stuck to his guns, that we were talking about a contractual matter, and that the skilled employees were employed by RCA Ltd on behalf of the United States government.

For the Liberals, John Pardoe (North Cornwall) made the point that if the Minister was to state a new government doctrine that because the Americans have large investments in something here, they can dictate the terms, it would be a sorry outlook for North Sea oil, and for all the other American investments in this country. Gilmour became his most aristocratic—which is very pure-mandarinic indeed. Mr Pardoe's remarks did not merit a threatening tone. "These employees have been given what they are entitled to," he reasserted.



The truth as MPs see it is that no multinational company would have dared to behave in this way—and for the British and American governments to connive in such a situation is shameful. I bet that "Orfordness" will creep into the vocabulary of the 70s to indicate a situation where people have suddenly been turfed out of their posts, through a decision of faceless men, taken 4000 miles overseas. Gilmour blames the way in which the Labour government drew up the original contractual agreement. The Opposition blames Mr Gilmour and Lord Carrington for not being tougher with the Americans. It's going to be a cause celebre.

★ ★ ★

There is a great deal of interest among MPs in the continuing saga of the Maendy and Brofiscum quarries. Peter Thomas, the Secretary of State for Wales, told the persistent local MP, Brynmor John, an extremely able attorney, that he had already received from Monsanto Ltd a detailed list of the material tipped. He had also asked the waste disposal firm concerned to provide any additional information it had on the materials deposited, to supplement that already available in the Welsh Office. He gave the House the assurance that he was keeping in close touch with the local authorities, who had the initial responsibility under the Public Health Act to investigate.

John retorted that in the New Scientist of 21 June, a Welsh Office official was reported as saying that the Welsh Office officials had not investigated the drums of chemicals on the site, "because it was not their job to do so". He asked if the precaution was being taken to see that drums were opened and examined.

The Secretary of State—I hardly blame him—was not immediately familiar with the state of the drums. Instead, he preferred to observe that under Part III of the Public Health Act, local public health authorities have the responsibility to investigate accumulations or deposits which may be considered to be prejudicial to health or a nuisance.

Alec Jones (Rhondda West) wanted to know about other sites in Wales. Thomas assured him that investigations are being made throughout the whole of Wales to ascertain what tipping has taken place over the years. Rather self-defensively, he asserted that local authorities were asked a long time ago to send in reports. Throughout the UK, enquiries were going on. Some of us hope that Maendy will do for pollution what another Welsh catastrophe, the scandal at two wards of the Ely Hospital, did for the cause of mental health.

★ ★ ★

First Enoch Powell, now Neil Marten. New Scientist contributor Adrian Hope has certainly stirred the Parliamentary dovecot—and how rightly! Sir Geoffrey Howe told him that he expected no change from the Munich decision, when that decision came up for confirmation in September. Anti-Marketeer Marten pointed out that English was the most widely spoken language, and the British Patents Office has the best expertise in the world. Why then, on grounds of efficiency, should the office not be in Britain? Sir Geoffrey Howe, who is a great one for prefacing any arguable statement with "the fact is", contended that the convention (which had not yet been completely negotiated) concerned 21 countries in Europe, and they had taken into account all sorts of matters, including the existence of one institution at The Hague. He refused to hold out any hope that there would be a change in the basic decision to have it at Munich.

Former Council of Europe President and arch-Marketeer Sir Geoffrey de Freitas weighed in with the fact that most of the patents are registered in this country. Sir Geoffrey took refuge in the value to British industry and inventors of a patent available not only in the EEC, but in other countries in Europe. Trevor Skeet (Bedford) then asked a jugular question. If we were to lose the European Patents Office to Munich, would the Trade Mark Office come to London and be sited in the United Kingdom? Sir Geoffrey, always one to mollify a supporter, said that Mr Skeet was right to remind us all that the Patent Office was not the only European institution which was likely to be set up. We expected to get a reasonable share of such institutions in this country. He noted Mr Skeet's remarks.

Smarting from my wounds about the stiff treatment meted out by the Hardman Committee report on civil service dispersal, I shall open the bidding for the European Trade Mark Office to come to Scotland. It's at least fair game to have a try! And, actually, because trade marks tend to be superseding patents in importance, the European Trade Mark Office could be the greater prize. Seriously, if it comes to Britain, it ought to go to a development area, near a good airport. Glasgow and Prestwick fit the bill. And, before Trade Mark experts throw up their hands in horror at the prospect of exile to Ultima Thule, may I remind them that within a few miles of Glasgow is some of the loveliest countryside in Europe, and recreational facilities are being built to match.

Tam Dalyell MP

New York view

Does new math add up to much?

In recent years, thousands of American parents recruited to help their children with their arithmetic homework have found out to their extreme discomfiture just what it feels like to be behind the times scientifically. The cause of their discomfiture has been "new math"—a new approach to teaching mathematics that stresses the abstract concepts of the subject rather than the basic skills of adding, substracting, multiplying and dividing that most of the over-25 generation remember from their own schooldays. Originally introduced in the late 1950s, new math has since caught on slowly but surely, and now more than 80 per cent of the school systems across the US teach mathematics in this way to children of all ages, from five to 18. The wide use of the new math has not, apparently, brought about a marked improvement in mathematical skill among American youngsters. In fact, the reverse seems to be the case, and now new math is facing a backlash reaction from suspicious parents, teachers and students who argue that the new-fangled method of teaching mathematics is actually creating a generation of mathematically illiterate schoolchildren. The rationale behind the new math is to equip children as early as possible with an understanding of the basic principles that underpin the subject of mathematics. Thus, youngsters are exposed to such concepts as set theory and number theory virtually as soon as they learn to count. Soon after, they start to wrestle with number systems to bases other than 10. And by the time they reach secondary school level they are ready to delve into symbolic logic. In learning the subject this way, promoters of new math believe that children will find mathematics more pleasant and intellectually satisfying than they would picking up the basic computation skills by rote. Further, children exposed to new math are expected to gain a sure grasp of how to use mathematics to solve problems, and along the way to pick up the basic skills of addition, subtraction etc—although as one new math policy statement published some 10 years ago made clear, "we are definitely opposed to the view that the main objective of mathematical teaching is arithmetic proficiency". The problem is that students brought up on the new math seem both to be lacking in arithmetic proficiency and to be having no more fun learning mathematics than their older brothers and sisters who picked up their skills the hard way.

Ten years ago, for example, before the State of California adopted new math in its classrooms and textbooks, children in the state scored on average higher than children in 70 per cent of US schools. After the new math, California students could manage no better than 38 per cent of American children. Similarly, the computing abilities of New Hampshire schoolchildren dropped so drastically after new math was introduced that school administrators decided to reintroduce some of the old-style arithmetic teaching into the classes. And teachers in San Francisco became so discouraged with their new math textbooks that they started to distribute their own mimeographed lessons in class.

The critics of the new math also raise the question of whether students really enjoy the new courses more than they did the old. "Mathematics proper does not appeal to most students, and they constantly ask the question 'why do I have to learn this material?' " noted New York University Professor Morris Kline, who has recently written a book highly critical of new math. Other critics point out that even more than old style arithmetic, new math runs the risk of being irrelevant to anything in the child's experience.

The criticism is not all one way. Many advocates of new math still adhere to the view that computational ability is the least necessary skill required of any mathematics course since, within a few years, all children—and adults for that matter—will be equipped with their own miniature calculators. But even the most bullish of the new math promoters concede that, as now taught, new math leaves something to be desired. The basic reason appears to be the fact that the increasing popularity of this approach in the early 1960s spawned a number of new math programmes that simply weren't tailored to the abilities of teachers or students.

"Most teachers in elementary schools aren't math oriented," explains Howard Hansen of the National Science Foundation, a body that has supported many of the efforts to perfect new math. "Teaching math is a fear task for most of them. And getting modern mathematical concepts over to them has been difficult." Thus the search is now on for ways of integrating the new math and old arithmetic in such a way that children will gain both an understanding of the fundamental concepts of mathematics and good grasp of the basic skills of addition, subtraction, and the like. This summer the National Foundation is sponsoring four conferences and workshops geared to that end, and experts in a number of university departments of education are working on updated versions of new math that take into account such recent developments as the wholesale use of computers in schools.

One major improvement in new math courses definitely under way is the removal of complex mathematical symbols that, more than anything else, confused parents face with their children's homework. In time, it seems likely that a synthesis will be achieved between new math and old arithmetic that will at least be simple enough for children to explain to their parents.

Peter Gwynne

West Coast scene

California's outfalls

California has 1000 miles of coast stretching from the sun-drenched, sandy beaches of the south to the timbered, precipitous sea-cliffs of the north. The coast is one of the state's greatest resources, but its value is often undermined by conflicts in its multiple uses. The problem is particularly acute in southern California where more than half of the state's 20 million persons reside. The coast and its adjacent waters are used for myriad forms of recreation, housing and other construction, offshore oil exploitation, commercial and sport fishing, sewage disposal, and military installations. In 1969, in an unprecedented move, five local agencies combined their resources to sponsor a study into one of the most sensitive issues of the area—water quality and coastal marine ecology. The first phase of the study, which lasted three years, presented some data and evaluations that should cause sober reflection on the part of environmentalists and others concerned with water quality.

The study known as the Southern California Coastal Water Research Project (SCCWRP; rhymes with slurp) received support from the major county (shire) sanitation districts and from the two major cities, Los Angeles and San Diego, in the region. The local agencies set up a SCCWRP commission and a scientific consulting board that oversaw the research and coordinated the study. The scientific contingent included marine biologists, chemists, geologists and physicists who conducted the necessary research and called upon numerous colleagues when the occasion arose. Professor John D. Isaacs (Scripps Institution of Oceanography) chaired the consulting board. They were charged with exploring the physical, chemical and biological processes and phenomena in the waters off the coast known as the Southern California Bight and to relate these findings to water quality management systems and to specify further research requirements.

What is perhaps the most intriguing result of the three-year study seems to be rather self-evident. The standards of water quality are primarily set for inland freshwater bodies. The SCCWRP findings emphasise and reemphasise the fact that "the waters of the sea—particularly those of a deep, diverse, and rather strongly circulating region like the Southern California Bight—possess a resiliency of quite a different order than the freshwaters of the continent. The sea has always been a sink for the leaching of the land, and the resultant seawater is a solution so inimical to terrestrial and freshwater microscopic and macroscopic life that few forms can effect a transition." Furthermore they say that environmental practices developed for freshwater environments have little direct applicability to marine situations.

The creatures of the sea come in a wide variety of forms and functions allowing them to tolerate greater environmental extremes than are possible for freshwater and terrestrial communities. For example, the SCCWRP personnel started monitoring the Orange County sewage outfall 1·5 years before the authorities switched from an outfall terminating one mile offshore to one terminating five miles offshore. They found that the fauna rapidly recovers from environmental stress when sewage discharge is discontinued. Furthermore they reported that the concentration of trace metals in the sediments rapidly decreased due to exchange and mixing with the water column. Thus they claim that most changes are reversible.

The sewage discharge seems to affect a relatively small area. Within that area the fauna are particularly robust. The density of creatures is greatest near the outfalls, as might be expected. Most of the sewage contains nutrients that encourage growth. "Natural" nutrients usually sink to the bottom of the sea and are only available when the currents well them up from their depths. In the confined domain of a lake, these additional nutrients would encourage enough algae growth to choke off the lake's viability. The total flow of wastewater into Southern California waters is 2000 times less than the flow of the ocean currents that sweep through the Bight from the North Pacific Ocean. Independent of the environmental stress due to the discharge, the marine community in Southern California is subjected continuously to natural changes in atmospheric and oceanographic conditions.

Although the SCCWRP report commends the sanitation districts for their competent practices, there are several disturbing findings. A few species of bottom-dwelling fish experience fin-erosion disease in rather high proportions. The investigators were not able to correlate this disease with any of the substances they monitored. These include DDT, PCBs and trace metals. The group strongly recommended strict controls of chlorinated hydrocarbons, such as DDT and PCB, due to their potential hazard.

Cores of undisturbed sediments taken from the Santa Barbara basin showed an astounding increase of lead and mercury in the marine environment. Mercury in the sediments has doubled since the turn of the century and lead has increased by a factor of 10 in the past few decades. Ocean circulation models indicate that these two metals enter the ocean from the atmosphere. Thus the mercury levels are probably due to worldwide human activities rather than to local sources. The lead is attributed to leaded petrol used in automobiles.

The report recommended stricter controls on floatable material such as oil and plastics. Not only are these materials aestheticaly unpleasing but they can carry harmful microorganisms, such as sewage bacteria, to the surface where they can disperse to beaches and shellfish beds. The floatables defeat the whole purpose of having a submerged outfall.

One curious and as yet unexplained result emerged from the study. Bottom dwelling fish near the outfalls have less trace elements in their flesh than more distant fish. In some cases the levels are lower than for fish living in areas remote from man. It is possible that the abundance of nutrients cause the fish to grow rapidly and that the trace metals are diluted by the new tissue. When it is explained this result may be one of the most significant findings of the study.

Gerald Wick

Perspective

Now you see it, now . . . ?

Psychic research has kept everyone, subjects included, guessing for over 50 years now. Even when the results claimed by researchers apparently exceeded the proclamations of probability theory, it always seemed simplest to assume that the poor researchers involved had once again been duped by their subjects, or perhaps even some were themselves involved in this plot to fool the scientific community. Despite such strong rejection, psychic research has exhibited remarkable staying power and now it seems to have entered a new phase where the scope and depth of investigation may make it more difficult than ever before to lightly disregard the subject.

Since mid-1972, two physicists at Stanford Research Institute in Menlo Park, California have been investigating whether or not such exotic phenomena as telepathy, clairvoyance and psychokinesis are always the product of fraud. In describing the intentions behind the work, SRI said: "We are well aware that this area of research is one of the most controversial topics in modern science, in part because of its history of charlatanism and fraud. However, we do not feel that controversy should deter us from what we believe is a legitimate subject for scientific inquiry . . . It should be explored without prejudice."

Dr Harold Puthoff, a quantum and laser physics specialist, and Russel Targ, a plasma and laser physicist, recently completed the first phase of SRI's investigation of Uri Geller, a 26-year-old Israeli who makes no secret of the fact that though he will willingly submit to investigation by scientists, his real interest is demonstration of his abilities to as many people as possible through appearances on stage, film and television. This interest immediately raises the suspicions of scientists, to whom the subject is at best a highly controversial scientific matter.

Geller was brought from Israel to the US by Dr Andrija Puharich, who wanted to have scientists examine Geller and his talents. Geller's abilities had been witnessed by several well known members of the scientific community by the time he got to SRI. Wernher von Braun of NASA brought along an electronic calculator to a meeting with Geller and it refused to function normally. Physicist Gerald Feinberg of Columbia University in New York watched Geller apparently bend metal objects without touching them and commented: "There's no obvious way to explain what Geller does." In Germany with Dr Friedbert Karger of the Max Planck Institute in Munich, Geller stopped cable cars, shattered rings and deformed several other objects. Karger's response was: "From the point of view of physics, for the moment, one cannot say anything regarding the energy he uses. One does know that the energy occurs only in connection with people. But all energy so far known to physics is independent of people."

Fully aware of the likely scientific reactions to any work in the area of psychic phenomena, Puthoff and Targ adopted a variety of procedures to ensure as completely as possible that their subject would have no opportunity for fraud. Many of the sessions were filmed or videotaped, to indicate whether some kind of mass hypnosis might be occurring—though film or tape alone cannot necessarily prove anything else. Geller was not allowed to supply any of the materials used in the experiments and, where possible, the experiments were performed on a double-blind basis. During one set of experiments Geller was observed on the video monitors by a magician who watched for possible sleight of hand procedures; none were found.

In one experiment, a precision balance which was covered by a bell jar and attached to a continuous strip chart recorder was used. Geller was somehow able to cause a deflection of the balance: "On several occasions the subject caused the balance to respond as though a force were applied to the pen. This was evidenced by a corresponding displacement shown by the chart recorder. These displacements were 10 to 100 times larger than could be produced by striking the bell jar or the table or jumping on the floor." In another experiment, a gaussmeter (magnetometer) set to full-scale sensitivity of 0·3 gauss was used to determine if Geller could perturb magnetic fields. He moved his empty hands near the instrument and in filmed experiments was observed to cause a full-scale deflection without touching the instrument. An experiment disqualified from inclusion as a formal result, though recorded on film, shows that Geller was apparently able to deform a steel band in a way that would normally require more than 100 pounds of applied pressure to achieve the same effect. The experiment was disqualified because Geller did touch the ring to achieve the result and the ring could have been bent manually. SRI does state here that physical effects were observed which have so far remained unexplained.

In a series of double-blind experiments involving a die inside a steel box, Geller was able to tell eight times in a row what the orientation of the die was after the box had been vigorously shaken. The probability that this could happen by chance alone has been given as less than one in a million. He was also able to pass his hands over a row of 10 identical aluminium film cans, ony one of which contained an object. A randomly placed object was located 12 times consecutively without error, against odds of one to a trillion that this could occur by chance. Geller's procedure here was to eliminate cans he felt sure to be empty until about three were left and then choose which can contained the object. It was noticed during the experiment that he can apparently find objects in steel boxes better than in plastic, and that also he can find metal objects more reliably than nonmetal ones. In a sequence of seven picture-drawing double-blind experiments, Geller produced seven almost identical reproductions of the target pictures, with no errors. Interestingly, the reproductions were usually laterally inverted.

SRI's only public statement to date on the results says: "We draw no sweeping conclusions as to the nature of these phenomena or the need to call them psychical . . . All we can say at this point is that further investigation is clearly warranted." However before SRI had time to issue that statement, or indeed to even report the results at a symposium at Columbia University, Time magazine rushed out a statement accusing Geller of fraud. It cited the evidence of two Defense Department consultants who, it turns out, never actually saw any of the reported experiments in progress. Time also described how at a performance in its own offices, several magicians employed for the occasion said that they could fraudulently reproduce what Geller showed them—though nobody actually checked whether any of them could do so under conditions identical to those under which Geller performed that day in New York, much less those at SRI.

Targ's tempered response to the situation is: "It is hardly appropriate for either Defense Department consultants or editors of a popular newsmagazine to criticise controlled experiments at SRI on the basis of their own 'experiments', which even they admit were not controlled at all." Time reporters later attended the physics colloquium at Columbia where formal report of the results was made. The only comment which has since emanated from Time's editor responsible for the story, Leon Jaroff, and his research team of magicians, now suggests that Geller "apparently" deceived SRI.

In the meantime, Geller continues to demonstrate his talents on stage and television. At Berkeley and Stanford Universities, he recently demonstrated his telepathic and clairvoyant abilities. Appearing on the Jack Paar show on television, he bent a large steel nail, which Paar held in his own hands all during the demonstration, by stroking it lightly near the top with his index finger. It seems that Paar, like many others who have witnessed Geller close up, was somewhat shaken by the performance and retired from that evening's show before its completion.

Geller's abilities have most recently stimulated planning towards an international conference of eminent scientists to discuss the implications for science as a whole, and physics in particular, of the whole body of recent research into psychic phenomena, to be held next year in the US.

Anyone who can affect electrical and magnetic instruments at a distance is clearly of interest to the Defense Department and the indications are that it is more than intrigued by what Geller can do. He has now been examined by the R & D division of at least one major US corporation in Philadelphia and SRI plans to continue its investigations in the very near future. If the present data receive further support, it may well be that the insights of Einstein and Heisenberg into the role of the observer in relation to his measurements may have to be taken to include not just his instruments of observation, but eventually the observer himself in the deepest sense.

Brendan O'Regan

A groundling's notebook

Babies from jail

One of the nastier pieces of news in recent weeks (and the near past has had its fair share of nasty news) is the information that the Home Office has seen fit to reject the request of the wife of a long-term prisoner that it should be made possible for her to have a child by her incarcerated mate by the technique of artificial insemination. No reasons were given for officialdom's surly refusal to comply with this sober and sensible request.

The wife, whose name is Margaret Tuttle, is aged 30. She is a former beauty queen of Islington, and is therefore, presumably, a woman of some physical virtue, as well as being, quite clearly, a person possessing much more than the ordinary amount of courage and imagination. So it might be thought that she is exactly the kind of mother the authorities would be proud to support as a progenitor of a badly needed generation of Britons of a kind and caste able to ensure our national survival and prosperity in an increasingly tough and competitive world.

Her husband, James Tuttle, is serving an 18-year sentence for armed robbery. Mrs Tuttle has said (according to The Times of Wednesday last week), "I will be 40 and too old to start a family again when Jimmy comes out of prison."

Margaret Tuttle already has one boy, but has said "I want a baby to safeguard against anything happening to my son. I am starting a campaign to see if I can make the Home Office allow prisoners' wives to have babies by artificial insemination." Thus she not only displays the kind of responsible attitude toward parenthood and family planning which we are supposed to foster and applaud—she obviously also cares about the desires and the disabilities of her fellow citizens.

She is plainly a jewel—a good woman—and good women make good mothers and rear good children.

A doctor who is supporting her campaign has said, according to The Times, "I think the Home Office was at first taken off guard by Mrs Tuttle's request—after all, few wives of prisoners serving long sentences want children to add to their burden." He is absolutely right. He might have added that only an exceptional woman, finding herself in such a situation, would insist that the baby she so much desired should be the child of a man who could not play the part of husband or father for perhaps a decade. It is, after all, easy enough for an attractive woman of 30—a prison-widow—to find herself a new mate, either for the moment or for ever. So it appears that Mrs Tuttle is likely to be not just an intelligent woman and a caring mother, but that she must also be a splendid wife.

So—we are left to wonder *why* the authorities said "No". The first and most likely possibility is that, to the minds of the Whitehall moguls, the whole concept was just too redolent of Sex with a capital S—that it smacked of hedonism and the indulgences of the flesh. And, of course, the stern, reforming, puritanical and cruelly antiseptic ambience of our prison system must not be corrupted by soft practices and concessions to lust. It may be all right for those whom we lock away to be exposed to the mind-rotting folly of idleness, and the indignities of lack of privacy, and the will-sapping effects of subjugation to a minutely regulated daily pattern of activity, so that initiative rots and all self-confidence is drained away. It may seem permissible to soften the ugliness a very little by letting the captives revel in the intellectual excitement to be derived from watching television programmes like The Golden Shot, or by playing bingo, or by attending chapel to indulge in prayer. But Sex is definitely *out*.

It would be irrelevant to the official mind that the only kind of pleasure a husband might gain by providing an ejaculate of seminal fluid is no more than he can gain at any time by the simple act of masturbation, and that nobody yet has thought of a way of stopping *that* from happening within our prison fortresses. The point is, I suppose, that by agreeing to make it possible for a husband to send his sperm out through the prison gates for the insemination of his wife, the authorities would become accomplices to the entire operation, including the achievement of whatever carnal satisfaction might be involved.

If the authorities *are* shy on this account, then their timidity can be understood, because if they gave their blessing to the exercise, and if the news leaked out, then it is certain that a shriek of protest would issue from the throats of that band of neopuritans who have become so shrill in the land during recent years. However, there are far more important things at stake than safeguarding the peculiar susceptibilities of the members of the League of Light.

The two major considerations, or so it seems to me, are these. In the first place, has the sentence of the court which put the man into prison had, by chance, the effect of inflicting a punishment more far-reaching and severe than that contemplated when Parliament prescribed the punishment for the wrong which he has done? Secondly, has the convicted person's family suffered from his incarceration in a manner never contemplated either by Parliament or the courts? If either of these possibilities does in fact arise, then it is surely the absolute duty of authority (our servants) to correct the wrong as soon and as rapidly as possible.

I suggest that the penalty prescribed by Parliament for armed robbery was never intended to deny those found guilty of the crime the right to father a family. Even more certainly, Parliament can never have intended that the wives of armed robbers should be denied the right to motherhood. Perhaps in the bad old days these added penalties were an inevitable if *unintended* consequence of the *intended* penalty of close confinement. But now that the means exist for relieving a prisoner and his wife of such harsh and accidental extra punishment, and without in the least relaxing the proper sentence of the court, it is clearly society's duty to employ those means.

I wish Mrs Margaret Tuttle (and her husband) the very best of British luck.

Donald Gould

The week ahead

Saturday

At 9 pm, Dr Bronowski reaches part 11 of The Ascent of Man, in which he argues that Heisenberg's principle of uncertainty applies to the whole of human knowledge (BBC-2). Concerned with responsibility and the moral dilemma of the scientist in our time, Bronowski discusses the implications of the atomic bomb, and delivers a plea for tolerance from Auschwitz.

Wednesday

Man Alive (BBC-2, 8 pm) looks at "Maplin—right or wrong?". Reporter Jim Douglas Henry examines both the siting of Maplin and recent developments in the field of quiet aero-engines; in a discussion, both those for and against Maplin present their cases.

Thursday

Why do MPs often ask Ministers whether they intend to make a visit here, there or somewhere else? Certainly not because they are interested in Ministerial meandering as such. Usually, it is so that they can ask a particularly nasty supplementary question that might otherwise be deflected. In the first of a new series, The Advisers (BBC-2, 8 pm), the course of one particular parliamentary question, asked on 22 January by Roy Mason ("Mr Mason asked the Secretary of State for Trade and Industry if he will make an early official visit to Yorkshire and Humberside to discuss the changing industrial infrastructure and the need for improving communications, including the development of a regional airport"), is followed through the civil service machine—and shows how civil servants attempt to keep Ministers atop the situation.

At 8.30 pm, you could switch to BBC-1 for a Burke Special about making money. Oleaginous James himself says, "If you can happily burn a £20 note then this is not the programme for you." (Logical note: this does not mean that if you cannot happily burn a £20 note, then the programme *is* for you.)

Horizon offers us a second chance to see how bad our teeth are, in "Sorry I opened my mouth" (BBC-2, 9.25 pm).

Martin Sherwood

Tantalizer

No 303 Cognitive pneumatics

Five candidates stood for the Chair in Cognitive Pneumatics at Wessex recently, and the selectors went carefully. They ranked the five under each of three headings, giving 5 for 1st, 4 for 2nd, etc in each case. As the criteria were Weight of Publications, Sonority of Lecturing, and Persistance in Administration, the overall winner was bound to be the best man. No one gained the same place under two or more headings and each candidate finished with a different total.

Dr Airwick was top in nothing, scored 3 for Lecturing and finished third. Dr Borehead was top in Publishing and bottom in something else. Dr Crumthink scored 2 for Publication. Dr Drinkwell out-pointed Dr Empty in Lecturing. The new Professor is not the top lecturer nor was the top publisher the runner-up. Can you produce the selectors' complete table?

Martin Hollis

Solution to Tantalizer No 302

Deadliners

Twenty

Whenever T spent 1 hour writing and x hours thinking, R spends $\frac{x}{4}$ hours writing and 1 hour thinking. This solves for x=2. So T writes twice as fast as he thinks and R works twice as fast as T.

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Feedback

Bathing nasty but not so unhealthy

The British holiday maker's not infrequent discovery that the sea in which he is bathing is heavily polluted with human sewage has led to a running feud between hygiene pressure groups and the local authorities. The Consumer's Association, the latest body to take the matter up, offers, in its journal Which? (July), a transparently honest appraisal of the situation. It quotes disturbing figures from a recent report by the Department of the Environment on the 149 coastal sewerage authorities in 1972. These are responsible for 333 principal discharge pipes around the coast. The report shows that six out of every 10 pipes discharged sewage at or above the low water mark and in one case (Bridlington's) the stuff goes in—untreated—*above* the high water mark.

Which? asked just over 1000 families belonging to the Consumers' Association to fill in a questionnaire on their experiences while holidaying around the British coast last summer. An epidemiologist examined the reports by the 267 people who had been ill (only 55 consulted a doctor). It was found that as many non-bathers were ill as were bathers. The gastro-enteritis incidence, in particular, was the same for both categories.

This finding ties in with the report of the Public Health Laboratory Service on 3106 paratyphoid cases notified between 1953 and 1959. In only four of these was there a possible connection with polluted beaches, which led to the conclusion that "... bathing in sewage-polluted seawater carries only a negligible risk to health, even on beaches that are aesthetically very unsatisfactory".

Shifting its ground rather from the health angle, Which? argues that anyhow it's disgusting to have to swim among excreta and offers the disgusted ("almost everybody") the opportunity to help compile a record of complaints about British beaches.

Blows to the Opium growers

Last week's announcement that the Nepal government has banned the cultivation of marijuana and opium will be hailed as a small success in the fight against narcotics production in Asia. In Laos, however, where opium production has long been a major item in the national economy, things are not going so well, although, by an ironical twist, suppression of the trade may yet be achieved by the sternly puritanical, pro-communist Pathet Lao.

Writing in American Report ([illegible] June) John Everingham points out that US influence on the opium-growing regions was based almost entirely on Meo mercenaries and other guerrillas recruited by the CIA. Those forces were due to disbanded as part of the ceasefire agreement in May. Although war so disrupted the life of the hill peoples that in recent years opium production has fallen off to the point that native addicts have had to obtain their supplies from Thailand and Burma, the villagers are now streaming back to their homelands in the mountains where the 200 000 tribal Meo and Lao Trung villagers used to produce more than 100 tons of opium a year. The drying up of US funds, it is feared may drive Royal Laotian officials to supplement their reduced income by resorting to the opium trade. The Pathet Lao insurgents, in the regions where they are in control, start by allowing the people to continue in the old ways but as the grip on their loyalty tightens, opium growing for sale is banned and only enough to support established addicts is permitted and the possibility of new addictions drastically reduced. The bulk of the opium growing region lies behind the Pathet Lao lines.

Quote

"There's no point in going before a Conservative selection committee and telling them you're a PhD—it's like committing suicide."—

Rt Hon Norman St John Stevas, PhD (Lond), Dr of Sc and laws (Yale), Under-secretary of State for Education and Science, at a conference in London last week.

Room to breathe for some time yet

How long before Britain is covered end to end with buildings and roads? If your answer is "any day now" take heart from a paper in the Social Science Research Council's newsletter (June). The author, Dr R. H. Best of Wye College, London University, estimates about 800 years. He describes the Ecologist's figures (nearly 15 per cent) for the proportion of the world's land surface built on in 1952 as "ludicrously exaggerated". He would put it at between 2 per cent and 3 per cent.

He demolishes several long-cherished myths. For instance, it is *not* true, as many people assume, that the towns are today gobbling up the countryside faster than ever before. The greatest inroads, says Dr Best, were in the 1930s (60 000 acres a year). Since 1945 the figure has averaged 38 000 acres a year. Nor is it the case that London is sprawling faster than other urban areas. Not since 1960, anyhow. Urban growth is faster in regions like Lancashire and Durham. This despite the fact that rates of population growth are still highest in the south and east. Dr Best sees the convergence of land use towards an urban density of around 80 acres per 1000 population as a reflection of a more egalitarian society.

But going back to the question about paving over the country, according to the article it will take about 100 years to reach the point where a quarter of England and Wales becomes an urban area. The Netherlands will have got to that point by the year 2000, when the figure for England and Wales will be 14 per cent to 15 per cent and for West Germany, 17 per cent to 18 per cent.

Words and music

"Assisted resonance"—the electronic manipulation of concert hall acoustics—has made world famous the musical tone of London's Royal Festival Hall. The technique was evolved by Peter Parkin of the Building Research Establishment, and it is now available as a commercial package through the enterprise of AIRO (Acoustic Investigation and Research Organisation Ltd, London and Hemel Hempsted). The £30 000 "off the shelf" system for converting multi-purpose halls—usually pronounced "hells" by musicians because what's good for speeches is not for orchestras—was inaugurated at two York Festival concerts at the Central hall of the university last week. The trick is to prolong a selected range of 78 frequencies between 50Hz and 1250Hz by just twenty milliseconds.

The performance now available for the average hall has been aptly characterised by Peter Pears, the tenor, when giving the recipe to the acoustics magicians for the reconstructed Snape Hall at Aldeburgh as the impact of Britten's War Requiem sung in Ely Cathedral—"Magnificent sound and don't worry about hearing the words". This is somewhat paradoxical of Mr Pears who has a reputation for clarity among British singers. However, he does not believe people hear words unless they know them already.

Computer pulls the plug

New York City's 110 storey World Trade Centre is finally open, the first concrete monster to be wired up for power since the energy crisis became a cause célèbre. And if the twin towers wiring is any indication of current attitudes to power conservation, the crisis will persist. All the lights in the building are controlled by a massive central computer, which seems to function as nothing more or less than an exotic time switch, according to the NY newspaper The Village Voice. The computer ensures that during office hours all the lights in the building are on and that after office

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hours all the lights in the building are off. Individual rooms do not have individual light switches. That way no one can leave an office light burning all night by mistake and waste a couple of kilowatt hours of power. But by the same token on bright days when the sun pours in through the plentiful twin tower windows, no one can turn their lights off.

Physicist and professor Louis de Broglie receives from General Sir John Hackett, Principal of King's College, a presentation copy of Wave Mechanics: the First Fifty Years, which has just been published to mark the 50th anniversary of de Broglie's discovery of the wave nature of the electron

What the French think of science

Disillusion with science and scientists shows no signs of spreading to France, according to a public opinion poll organised by the Delegation general a la recherche scientifique et technique (DGRST). An analysis of the answers given by 1200 people, forming a cross section of the population, to a list of 50 questions was published by Le Monde.

The newspaper commented that while the French generally are strongly in favour of science they know very little about it. Their attitudes are often ambiguous and their motives contradictory. They put a high value on medical and environmentaly research but they are also keen on anything that will lead to a greater production of consumer goods. On the other hand military research and particularly space research failed to find favour.

Poorly informed people tended to cling to the mythology of the dedicated and disinterested scientist, but those in the higher educational brackets refused to put the scientist on a pedestal. Both groups, however, saw him as a man apart from his fellows. Listing the professions, the public put the doctor first, the scientist second, and the engineer third.

Patriotism showed up in the response to the statement: "if French scientists had the sort of funds available to others they would, without doubt be at the head of international research". Agreement was expressed by 79 per cent. The commonly observed nervousness in regard to nuclear matters seems to have little place in France. Those questioned were asked to suppose that the construction of a nuclear power plant was under discussion and the scientists had given an assurance that it presented no danger—how much trust could be placed in such assurance? 80 per cent expressed varying degrees of confidence, against 15 per cent who had no confidence at all and 6 per cent who didn't know.

China to launch met satellites

China is preparing to launch meteorological satellites, according to Mr Chi Sheng-ying, deputy director of the Central Meteorological Institute in Pekin. He led a Chinese delegation at an international meeting on meteorological satellites in Paris. Mr Chi Sheng-ying emphasised that space meteorology is of great importance to the Chinese economy. So far China has launched two scientific satellites—on 25 April, 1970 and 3 March, 1971 and is a member of the World Meteorological Organisation since joining the United Nations in 1971.

The last word on . . .

Thunder and lightning

In this present season of highly-charged atmospheres, climatic desires alternate between the immediate wish that thunder would roar to relieve the tension, and the later supplication, when it reverberates at three o'clock in the morning, that it should roll on rapidly to some place else. This fear aroused when the heavens go fortissimo may stem equally from modern recollections of decimating explosions and from atavistic memories that the sound of thunder, in most religions, was once the voice of the senior God. And it is not completely dispelled during a stentorian storm by the scientific assurance that all that is actually going on is that "the extreme heating and explosive expansion of air immediately around the path of a lightning flash sets up intense sound waves causing thunder to be heard". This could possibly be true, but it doesn't bring much immediate comfort to those of us burdened with such bad consciences that we cannot entirely dismiss the possibility that divine disapproval is at last being vocally expressed. The first threatening clap brings sharply to mind the retributory warning to Kai Lung that "when struck by a thunderbolt, it is unnecessary to consult the Book of Dates as to the precise nature of the omen".

If caught in a sonic storm outdoors, it is sensible to follow the advice of that mellifluous brontologist, Mr Harry Lillis Crosby, to the effect that "when it starts to thunder, don't run under a tree". The safest place for human beings in a thunderstorm today is considered to be in the centre of a town. Therein you are surrounded by high buildings, generally equipped with lightning conductors, which form an almost complete security screen to cut off all flashes at multi-storey level. If by ill-chance, you are electrically attacked in open country, apart from avoiding trees, expert opinion also abjures you to cast away fishing rods, golf clubs, forks, scythes, and even your umbrella. Should you perchance be carrying a pike or halberd, the high command of the Sealed Knot, that lovable society which spends its leisure re-enacting our Civil War battles in full historic fig, recommends that you dump it temporarily in the ditch. At a performance of the Battle of Worcester recently a Roundhead pikeman who was simultaneously standing in a puddle and leaning against a metal van was struck by lightning down his weapon and had to be borne away to hospital by the society's first-aiders, who are members of the Order of St John of the Knot. And in the context of more advanced aggression, it is prudent to stand well back from poised rockets when storm clouds gather because Saturn projectiles have been hit by lightning bolts on the pads at Cape Kennedy and one, during the launch of Apollo 12, such a strike temporarily knocked its whole electrical system.

Admitted thunder-lovers tend to be somewhat thin on the ground. Benjamin Franklin obviously welcomed its arrival over Philadelphia so that he might have opportunity to fly his exploratory kite; Adolf Hitler was said to have found pleasure in watching donner und blitzen detonate among the peaks before his eagle's nest at Berchtesgaden; and Marcus Cato the Censor celebrated matrimonially whenever the heavens reverberated over Ancient Rome. Plutarch reports that the puritan Cato, in process of turning out of the Senate one Manilius because he kissed his wife too lovingly in daytime, proclaimed with ascetic pride that he never embraced his own wife except when it thundered loudly. And it was therefore a pleasantry of his to remark that he was a happy man when it thundered. Plutarch didn't record just how Mrs Marcus Cato managed for conjugal bliss between thunderstorms. But if any married lady of today is beset by the same problem of a kinky, brontological mate who is only turned on by the sound of thunder, she might persuade him to move to Bogor, Java, Indonesia, where, on average, they have thunderstorms on 322 days of the year.

Patrick Ryan

Review

Exponential living

by Lord Bowden

The logarithmic century
by Ralph E. Lapp
Prentice-Hall, pp 264, $7·95

After 100 years in which businessmen, economists and politicians have urged us all to worship "growth" as a universal panacea for our troubles, the publication of Forrester and Meadows's book made us acutely conscious of the uncontrollable way in which some parts of our economy are growing—and using up the world's resources. The concept of The Limits to Growth has now become part of the conventional wisdom. Thousands of bewildered citizens have re-discovered Malthus and learned about exponential curves. The prophets of doom have come into their own again with all the authority of science to support them. I may have been less worried than some because I had heard similar stories before.

I remember that Svante Arrhenius predicted nearly 50 years ago that the world would run out of petrol long before the end of this century, and I learned about exponential growth when I was a small boy. Someone told me that for a couple of months a water lily had doubled its area every week until it covered half the pond. How long, I was asked, would it take before the whole pond was covered? I remember the intellectual effort involved in persuading myself that it would be precisely one week. I was helped, I remember, by the story of the forgotten hero who invented the game of chess and taught it to the Emperor of India. He asked in return for one grain of wheat on the first square of the chess board, two on the second, four on the third, eight on the fourth and so on. The Emperor soon found that there was not enough wheat in the world to pay him.

Dr Lapp provides a useful compendium that brings all these things up to date and makes clear the very considerable problems that confront the world today. His book contains a series of graphs and tables and charts, some of which show beyond a doubt that enterprises which have been growing exponentially for many a long year will have to stop growing very soon.

It does appear that the 20th century will witness the culmination of a very large number of growth curves. Many things grew exponentially throughout the 19th century, when they were quite small and unimportant, but something will burst if they go on growing after the year 2000. For example, the number of scientists in the world has been doubling every 12 or 15 years ever since the time of Sir Isaac Newton. There were only a few hundred in the world a century ago; today they outnumber the clergy—and probably the officers in the army. If one assumed a steady continuing, exponential growth, such as we have had for a couple of hundred years, every human being on the face of the Earth would be a scientist before long. In fact the number of undergraduates who are studying science and technology in England and the United States began to decline dramatically a couple of years ago. The number of electrical engineers doubles every 10 years, so that one could predict that in 50 years or so every scientist will be an electrical engineer and at the same time and for the same reason he is going to be a chemist and a medical man, and probably be unemployed! It is easy to make too much of these mathematical curiosities—we have already learned to live with many of them, as our forefathers did.

The great Abbey of Cluny, from which most of the monasteries of Europe claim descent, was founded in AD945. Within 250 years there were more than 8000 abbeys and monastic foundations in Europe, each of which aspired to found another institution like itself every 10 years or so. This is the perfect recipe for exponential growth and had it continued for another 100 years, every adult male in Europe would have been a monk, in which case presumably the exponential growth of the population would have come to an abrupt halt. The fact is, of course, that most curves of growth are s-shaped; after a splendid and riotous period in which nothing seems to interfere, growth is stopped by the absence of further resources.

We have probably been unduly complacent in the past, but there is no doubt at all that unless something dramatic occurs very soon, vital resources of the world will be eroded and vanish away for ever; when they have gone, our civilisation may collapse.

The oil companies always like to have proved reserves which will last for another 10 years, but at the rate at which the consumption of oil is growing these days, it seems wildly improbable that fresh reserves can be found fast enough, that if they are found that they can be exploited, or that ships can be found to take the oil from the fields to the users, or that enough oil can be refined when it has been brought ashore. It is almost certain that the consumption of oil will have to be controlled or reduced before long, and the sooner our society reconciles itself to this fact the better it will be for all of us. President Nixon is already trying to persuade Americans to use less gasoline. Perhaps our society *is* going to collapse before very long, as other civilisations have done before it, but it will struggle hard to survive. After he had written The Decline and Fall of the Roman Empire, Gibbon concluded that life in 18th century England was better than anything the world had seen since the Golden Age of the Antonines, in which wars, pestilence and famine made men fear that the end of the world was at hand. In fact mankind had to endure a dark age of nearly 1000 years before life was as good again. But if our modern worldwide civilisation does collapse, there may never be a new civilisation to succeed it, for we shall have used up all the raw materials for civilised living.

Dr Lapp provides a tremendous amount of information which should be studied by politicians, scientists, engineers and ordinary citizens. We must not assume too easily that we have lost control and that we are watching helplessly while this system which we have created is running away with us. Some day the last drop of oil may have been used, the last motor car immobilised and the last man who can find standing room on the face of the Earth be squeezed into his allotted space.

It is always very difficult to prophesy, particularly about the future, and extrapolation of the prices of common stock has ruined many a speculator. I wonder what the next dramatic exponential growth will be. Will it perhaps be of horses because we've run out of petrol? And if so, will the poor beasts be able to negotiate all those enormous clover leaf intersections on the motorways? Nearly 100 years ago people forecast that traffic in London would come to a standstill early in the present century and that the Euston Road in particular would be three feet deep in horse manure by 1910. Extrapolation is always dangerous.

Most ordinary citizens are far more worried about the apparently exponential rise in prices, particularly the price of houses. The average house owner earned more last year by the appreciation of the value of his house than he did from his take home pay after taxes, and he was no better off as a result. How long can this sort of thing go on without destroying the financial structure upon which modern industrial society depends from day to day? The real limit to growth may turn out to be the collapse of the money market, or the shortage of gold, rather than war, pestilence and famine. Who knows? We live in difficult times, as our Fathers did before us; many of us are still very comfortable and millions still enjoy a higher standard of living than the world has ever seen before. Dr Ralph Lapp's book may help us to survive.

Lord Bowden is principal of the University of Manchester Institute of Science and Technology

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The sovereign state: the secret history of ITT
by Anthony Sampson
Hodder & Stoughton, pp 288, £2·95

Does anybody—except Harold S. Geneen—love ITT? I remember how six years ago, having lunch with Eileen Shanahan, the respected New York Times reporter, she shook her head and reflected, "It's a shabby company". Little did she know. A few days later an executive of ITT walked into her Washington newsroom and asked to see the story she was writing about ITT's hotly contested proposal to merge with ABC, one of the three American national television networks. When she refused, she was given a veiled threat about the possibility of the Times losing its licence for its radio station. Later her private life was investigated.

The Shanahan incident is one of the copious, telling bits of evidence that Mr Anthony Sampson uses in his new book dissecting the International Telephone and Telegraph Corporation. His techniques of analysis, in the past turned on Britain and Europe, are especially appropriate to a corporation, for a commercial organisation, far more than a country, is analagous to a human personality and ITT, in its 53 years, has been run by just two.

ITT, now the eleventh largest corporation in the world, was founded in 1920 by Colonel Sosthenes Behn, a man of Danish-French origin who became American when the United States bought his birthplace, the Virgin Islands. From the beginning, ITT was a shapeless, pushy expatriate. Colonel Behn began in Puerto Rico to build the international telephone company he dreamed of and he chose its name deliberately to cause confusion with the powerful American giant, the American Telephone and Telegraph Company. With telephones as an entrée, ITT moved into Europe and Latin America, bearing different titles in every country and trying to appear a national flower wherever it took root.

Today, under the tight management of Harold Geneen, who took command in 1959, it has moved into hundreds of industries as remote from telephones as rented cars, bread and secretarial schools. ITT is the most conspicuous of the multinational conglomerates; it operates in 70 countries and nobody confuses it with AT&T any more. (ITT dropped the ampersand in the 1950s.)

Sampson concentrates his book on the three major attempts to manipulate the Nixon Administration for which the corporation, and the Administration, are now in trouble in the United States. One was the promise to contribute $400 000 to the Republican National Convention last year. Another was the efforts, which probably included the $400 000 contribution, to get the Justice Department to drop the biggest anti-trust suit in its history, through which it was trying to prevent ITT from securing its own biggest acquisition, the Hartford Insurance Company. The third, perhaps most sinister, were its manoeuvres to enlist the Central Intelligence Agency to prevent the election of Dr Allande in Chile (where ITT ran the telephone service) and then, once he was elected, to depose him.

There are many similar unlovely stories in ITT's past which are served up by Sampson. In the 1930s Colonel Behn kept on the good side of Hitler and even bought a 28 per cent interest for ITT in Focke-Wulfe, whose bombers were used against Britain (where ITT owned Standard Telephones and Cables) and other American allies. He persuaded Franco to let ITT keep its hold on Standard Electrica of Spain, which still has a monopoly on Spain's telephone supplies, and he kept ITT strong in Latin America despite its wartime ties with Berlin. In 1954, Sampson relates, ITT found a useful contact in the then Defence Secretary Harold Macmillan in trying to get British landing rights for a submarine cable, even though the cable would compete with the British nationalised Cable and Wireless Ltd. And the stories are more unpleasant when they deal with private companies; neither the Hartford or the Abbey Life (in Britain) insurance companies wanted to be blended into ITT.

So? The two main claims of this book are doubtful. One is that ITT is as powerful as if it were a nation. The other is that it is the very model of the new type of multinational conglomerate, all the more sinister because it deals with communications.

What is so conspicuous in the evidence amassed in this book and which contradicts the sovereign-state hypothesis are ITT's failures. It is not a success story. It did not get the cable landing rights. It did not unseat Dr Allende. It did not get ABC. It did not get the Republican convention into San Diego (and thereby President Nixon into ITT's new Sheraton Hotel). It has not had any visible influence on international communications satellite policy. It has not (and here Mr Sampson exaggerates its success) in Britain got the Post Office to back its big new electronic telephone exchange, the TXE-4, to anything like the extent it expected. (The TXE-4 is made by STC, ITT's biggest British subsidiary.) And while it still clings to Hartford, it is paying a penalty—the compulsory divestiture of Avis Rent-a-cars, Levitt Houses, Canteen vending machines and part of the Grinnell company.

ITT is not a model of a multi-national because its base still is the stodgy, nationalistic business of making telephones. It does not have the advantage that IBM has of marketing a single kind of product wherever it goes; neither can it be a true conglomerate, interested only in the profits of companies rather than their products. For it is stuck with pleasing Posts and Telecommunications Authorities (the bulk of its business in Europe is PTT work) and these, as the British Post Office has shown, want their own designs and have no interest in lowering national barriers.

ITT is vulnerable. Sampson deftly expresses its empire as a pyramid balanced on a pinpoint—the price of ITT shares. New acquisitions are bought with shares, not with cash, and the financial world has known for some time that ITT's apparent growth in earnings is based largely on the sales of the assets of the companies it acquires. To continue strong, it must survive the current crop of scandals and also the eventual departure of its legendary (albeit nondescript) chairman, Geneen, who, in his mid-sixties, keeps an eye on every detail of the vast network. ITT is probably a model of nothing but ITT. Of that. Sampson has drawn a wondrous awful portrait. *Brenda Maddox*

Stalking the wild taboo

by Garrett Hardin

William Kaufmann, pp 240, $8·95

Garrett Hardin, professor of human ecology at the University of California, needs little introduction to readers of this journal and followers of the conservation debates. He has chosen for reprinting some periodical contributions and lecture texts ranging in date from 1963 to 1972, on abortion reform (for which he was a campaigner), technology and population. They all come roughly in the area of science and government, and qualify for inclusion because they exemplify his war of attrition against what he calls modern taboos, "prohibitions excluding something from use, approach or mention".

They are rather mixed in quality: taboo-stalking, as Hardin sees it, admits material too diverse to make a wholly satisfying book. The best pieces are those in which he considers the biological principle of competitive exclusion. This states that in the animal world "complete competitors cannot coexist". He uses it to support his argument that there will be no "natural" transition to stable populations and that positive control measures will have to be taken if much less pleasant consequences are to be avoided. For this purpose human "tribes", Protestant or Catholic Irish, Jews or Arabs, White or Coloured, can be considered as species. He claims, too, that competitiveness has been tabooed and more or less ignored by sociologists. Considering social systems, he suggests that ethical values can be built into models, indeed, must be, if planning for stability is to be possible. It is all very abstract, subtle stuff. The total disagreement over The Limits to Growth comes to mind to indicate that such models are way beyond our capabilities at present.

The pitfall of this genre, repetition, is not entirely avoided, and the book has a slightly unworthy, gimmicky tone, in the throwaway title and the choice of brown ink on tan paper. Scientifically this has been shown to be the most readable combination, but there has been a taboo on its general adoption. I wish human ecology were an unnecessary subject, but this exponent is persuasive.

John Hewish

Cults of unreason

by Christopher Evans

Harrap, pp 264, £3·00

Chris Evans's latest book is compulsive reading—rare for a work of non-fiction—and I devoured it in the way I like to read novels, in a single day. This was helped, perhaps, by the book's curious organisation. The largest chunk (the first half) describes scientology, its bizarre history and recent troubles, and its forerunner, L. Ron Hubbard's dianetics. The next section, on flying saucers and other UFOs, is the next longest. This is followed by shorter coverage of black boxes (from George de la Warr's famous range of models to present-day alpha rhythm machines), Eastern gurus of various sorts, and a rag bag of other freakish manifestations of the irrational. Though all are handled both critically and sympathetically (surprisingly so, in places), there is thus a feeling that topics are covered less thoroughly as the book proceeds. The pace is that of a downhill gallop, with a somewhat abrupt ending.

Evans is always vivid and informative, sometimes arrogant (". . . a point of significance which has been almost exclusively missed by previous commentators . . .") but never remotely boring, even when dealing with some of the more absurd gibberish propounded by the practitioners he describes. His account of scientology is by far the best I have ever read, and much else (such as the incredible story of Lobsang Rampa, the Tibetan lama also known as Cyril Hoskins of Thames Ditton) makes the book into a rattling good compendium.

My complaints are minimal. First, there are a number of places where Evans could have given more information to help the reader to assess the authenticity of particular claims. For example, he lists the composition of Hubbard's "Dianazene", a vitamin mixture supposed to protect the body against radiation damage, and suggests that its value is doubtful, but offers no guidance about its likely efficacy. A few words of critical evaluation here and in other similar places would have been helpful.

Secondly, Evans believes that we "have let our technical mastery of science move far, far ahead of our philosophical and social expertise", and that this has created the vacuum which is being filled by the various cults he describes. But he says disappointingly little about the psychological foundations of his thesis. What, for example, does it mean to argue that some of the devotees of scientology are "inadequate" people? Unless such explanations are to be simply convenient labels, they need rather more analysis than they receive, for the most part, in this book. Perhaps, having written a unique and lively sourcebook on the cults of unreason, Chris Evans will turn to this tricky task in a future volume?

Bernard Dixon

Breakfast of champions

by Kurt Vonnegut jr
Jonathan Cape, pp 296, £2·25

After Slaughterhouse Five ("A Duty-dance With Death"), it was rumoured that Vonnegut had finished with the novel as an out-dated medium for trying to express the oneness of the universe. With the advantage of hindsight, it now seems that all of his writing before Breakfast of Champions has been merely a cantering-ground, a prolonged test-run of his wry wit and fantastically fertile imagination—a talent of near-genius trying to reconcile itself with its message. Indeed, it is Vonnegut's imagination that pulls us through the bulk of his writings and makes them masterpieces of readability. Who can ever forget the hilarious antics of The Church of God, The Utterly Indifferent, the strange, short odyssey of Wanda June's birthday cake, or the four-dimensional vision of the Tralfamadorians who see stars not as points of light but "the heavens filled with rarefied, luminous spaghetti." But Happy Birthday, Wanda June was a deserved failure, and Slaughterhouse Five an unmerited success. "The most original anti-war novel since Catch-22," says the blurb. Anti-war? You coulda fooled me.

But at last Vonnegut has come to terms with his extra-terrestrial vision and taken a characteristic, highly objective and hilariously pessimistic view of Earth as no one, not Wells, not Stapledon, not Asimov, has done before. Breakfast of Champions is about a poisoned planet as typified by a last-gasping USA. Pessimistic: Kago, a space-traveller who has visited a planet where the automobile inhabitants have exhausted their supply of fossil fuels, comes to Earth to warn the citizens of Detroit of the danger they can still avert. "But he was so tiny that nobody paid any attention to him. A drunk automobile worker in a bar in Detroit mistook him for a kitchen match. He killed Kago by trying to strike him repeatedly on the underside of the bar." A flying-saucer creature named Zog comes to Earth from the planet Margo "where the natives conversed by means of farts and tap-dancing." The first thing Zog saw when he landed, was a house on fire. "He rushed into the house farting and tap-dancing, warning the people of the terrible danger. The head of the house brained him with golf club." Kago and Zog don't feature large in the book. They are figments of the imagination of Kilgore Trout, the penniless S-F writer who can get into print only by way of filling the spaces between illustrations in dirty sex books.

Kilgore Trout's alter ego is a fabulously well-to-do car-dealer in a Midland City who is fast going insane from "bad chemicals in his head". Dwayne Hoover's only true friend is his dog. "Sparky could not wag his tail because of an automobile accident many years ago, so he had no way of telling other dogs how friendly he was. He had to fight all the time. His ears were in tatters. He was lumpy with scars."

Breakfast of Champions is original in structure. In its 25 chapters, which begin with a cruel, humorous but true history of the USA, Trout and Hoover don't meet until number 22, and even then their contact is fleeting, not to say peremptory. The previous episodes alternate between Trout's billy-pilgrimage through the American landscape to Midland City for an arts festival, and Hoover's progress through his poisoned sanity to the point where he runs irretrievably amok. Trout is the ingenu, the Candide whose best of all possible worlds has become today's manmade muckheap. Hoover is the subjective man whose mind can no longer run parallel with the insanity of his environment.

Upon this vehicle, Vonnegut conveys to us man's essential barbarism to his fellow men, to his designated slaves, to his world, and to himself. He conveys to us the futility of relying upon our old stand-by friends, logic, amicability, and resignation to our more human but less benign social attributes to pull us through the mess that we have landed ourselves and our future in.

Breakfast of Champions triumphs as an entertaining and doomladen message. As a novel it fails because Vonnegut doesn't leave us with any clear feeling of finality or expectancy. Once Trout and Hoover have met, and Hoover receives the book that finally drives him into madness, there is little left for him, or Vonnegut, to do except litter the stage with the victims of Hoover's insane paranoia.

But at last Vonnegut has shown himself as a man who cares deeply about the plight of all of us on Earth. He involves himself, in mid-life crisis, in the crisis of the world; and leaves us, as though he will never write again, with the image of his tear-filled right eye.

John Goldblatt

International zoo yearbook, vol 13, 1973

edited by Nicole Duplaix-Hall
Zoological Society, pp 424, £1

This year's International Zoo Yearbook fully maintains the high standard set by its dozen predecessors. The special theme chosen for the first section is waterfowl in captivity, and opens with essays by Dr Konrad Lorenz and Sir Peter Scott. The fame of Lorenz's human-imprinted geese almost rivals that of Disney's irascible duck, and Sir Peter's establishment at Slimbridge leads the world in waterfowl conservation.

Asked "what is a Coscoroba?", most educated people and many naturalists would have to admit defeat. With the appearance of a small swan, this curious bird of the far south of South America has features linking it with the tropical whistling ducks. Success in breeding this and the far more rare Cape Barren goose are two items of good news that are reported in interesting detail.

Many of the contributions to the rest of the book are included in the chapter on breeding. The curious bush dog (Speothos venaticus) of South America is a little known and probably endangered species, and I am glad to hear of success in breeding it at Los Angeles and Frankfurt. All too frequently animals are born or hatched successfully in captivity, only to die in infancy. It is therefore consoling to read of the exuberant and prosperous fecundity of a tailless tenrec at Wassenaar zoo. She gave birth in successive years to litters of 19 and 31, and in each case only one baby tenrec died.

Care and feeding of animals is dealt with in a chapter on husbandry, and architecture and education are the subjects of two other sections. A long reference section gives in tabular form information on breeding, and a census of individuals of rare and endangered species known to be living in captivity. It is recorded that Chinese zoos have sent in no census returns since 1965. This seems strange since their zoos are well run and contain species not living in captivity anywhere else in the world. I hope that next year will see this deficiency remedied.

Michael Tweedie

The naturalist in central southern England

by Derrick Knowlton

David & Charles, pp 240, £4·50

Here's the fourth volume in a regional series which has so far covered the Isle of Man, Wales, and Devon and Cornwall. The general plan is to define the main habitats of the region and to describe the ecological community of plant and animal life to be found in each habitat. Roughly speaking, it aims to do for the naturalist what a Good Food Guide does for the gourmet. The specialities of the region are listed in the main text, and apendices provide map-references and addresses to steer the visitor to the museums, local societies, nature reserves, attractive vantage-points and observation posts that will help him to see and hear the subjects of his choice.

"Central Southern England" is the meteorologists's equivalent of Hardy's Wessex—England south of the Thames valley and separating Devon from the Home Counties. It is the classic ground of Gilbert White and Richard Jefferies and W. H. Hudson—a tempting but challenging subject for any naturalist-author who chooses to follow in their footsteps. Mr Knowlton's method is a soberly factual one, and there are certainly facts enough to fill a book in a survey which encompasses the chalk and limestone downland of Wiltshire and Dorset, the peat moors of Somerset, the Hampshire estuaries, the New Forest and the sandy waste of Egdon, to name only some of the attractive and contrasting components in Mr Knowlton's total landscape. With so much demanding to be mentioned it is perhaps inevitable that the book should sometimes become simply a catalogue. The attempt to do justice to everything from offshore velvet scoters to a cabbage root-fly in the gardens demands a larger book or a smaller region. But when that is said, one must admire the thoroughness and the extensive personal experience that Mr Knowlton brings to his task. No-one is better qualified than he to attempt so comprehensive a survey.

Desmond Hawkins

Focus on environmental geology

edited by Ronald W. Tank

Oxford University Press, pp 474, £2·25

When our ancestors took to farming, they changed the face of the landscape to produce the countryside we know today. In Britain the change occurred so long ago that we have to study fossil pollen to date the destruction of the forests and the spread of the weeds of cultivation that followed. In New Zealand or on the Great Plains of America the change occurred within the lifetime of our grandparents. Their tools were the axe and the forest fire, yet with these they revolutionised their surroundings to found the world we live in.

In the wake of that revolution came the changes which concern us so much today and which form the subject of this fascinating book. With the energy at our command we can move rock in shovelfuls of one hundred tons at a time, make lakes the size of Wales and reach out from Antarctica to Alaska for yet more sources of energy.

Can anyone seriously argue that we wish to return to the days of the hand axe? For good or ill we are set on this course. We have therefore to teach ourselves, as Senator Muskie says in his foreword, to understand our physical environment so that we can gather what we need without causing disaster on the way.

Professor Tank has chosen more than 40 original articles and linked them with a brief commentary. Through breadth of choice he avoids the pitfalls of the partisan yet brings out the essence of the dilemma. Can we emulate our ancestors who in creating their farmlands produced a world as attractive as rural Britain or New Zealand?

The book opens with articles on geological hazards; eruptions, earthquakes, landslides, subsidence and flood: some man-made, but many inherent in the behaviour of the planet so that early warning rather than control is the best we can look for.

It is a sobering thought that civilised man has not yet seen an eruption on the largest scale, so infrequent are such events. An eruption at Crater Lake in southern Oregon 7000 years ago produced a carpet of volcanic debris which stretched for 700 miles into Canada. Crandell and Waldron show how an understanding of such events can lead to intelligent siting of man's activities around the deceptively peaceful volcanoes of the Cascade Range.

The second half of the book comes to the heart of our dilemma. Here are the statistics which spell out our demands for energy, water and minerals and for yet more dumping grounds for waste, all complicated by man's habit of crowding into cities. This statement of needs forms a background to accounts of individual disasters and examples of mismanagement which can be set against man's overall success in extracting his necessities from the Earth.

As Senator Muskie points out, the geologist has the double responsibility of trying to understand our physical environment and of communicating that understanding so that public debate is informed and sensible decisions result. Professor Tank has made a notable contribution to this debate.

John Sutton FRS

Theatre

Every packet carries a government health warning

Cambridge Footlights '73

The Round House, London

Late Night Season: 3-14 July

The annual Cambridge Footlights Revue is an institution, and consequently to review it is like doing a write-up of the Trooping the Colour. "Her Majesty the Queen turned in the workmanlike performance we have come to expect of her, while a lot of soldiers stood in line and walked about, cleverly putting one foot in front of the other in time to some rather jolly music . . . etc, etc."

This year's show fits snugly into the Cambridge tradition—in fact, to the point of familiarity. It was surprising to see the targets of 10 years ago still being affectionately pummelled: the Kama Sutra, Astaire and Rogers, the Archers, Sunday Drivers, Scat Singing—how nice to know that things have not changed since then! (Thank you nurse, but I shall not require the commode until after the port and walnuts.) There is an old-fashioned air about the whole thing, although admittedly a whiff of camp nostalgia here and there. Even the parody pop song owes more to Adam Faith than to Alice Cooper.

Well, and what's wrong with being old fashioned, you may say? Quite right —nothing wrong in it at all—merely an observation. The only valid judgement that can be made is—how funny is it? Regrettably, only quite.

The show has its moments, of course. It is performed by a cast who do their material more than justice. Robert Benton has an elegant dead-pan style which reaches its peak in a steely send-up of the gloomy songs of Leonard Cohen. Jeremy Browne overcomes his naturally funny looks to provide genuinely subtle touches, particularly in an earnest appeal on behalf of people who fall down lavatories. John Lloyd contributes a gleefully degenerate impersonation of any Oscar Wilde hero. The rest of the cast, Pam Scobie, Mary Allen, Frank Ries, Jon Canter, and Griffith Rhys Jones, carry things through with a meaty gusto. If nobody shines all the time, at least they never do less than twinkle. The main quibble with the performances in general is with the cast's delicacy in dealing with puns (of which there are many). The tendency seems to be to hold the dangerous pun, or "jeu de mot", at arms length before dropping it plonkingly into the lap of the audience. I personally prefer the salvo technique, flinging the thing straight in the face of the enemy, and following it up with another before they have recovered from the assault.

However, the show is not as rib-tickling as might have been hoped, largely due to the quality of the material. Apart from the Cohen song by Smith and Adams, some good groan/chuckle-worthy pieces by John Parry, an indulgintellectual Oedipus/Oscar Wilde sketch by Stephen Wyatt, and a satisfying parody of "My Way" by Jerry Browne, the writing is disappointingly low on guffaws. Stephen Wyatt's production, energetic in the musical numbers, is unfortunately static in the verbal sequences. There is an awful lot of standing still and talking to the audience. All the same, it is extraordinary that the transient population of one university should produce, year after year, a comic revue of considerable standards. As an institution, this year's show may not be a great vintage, but at least it's funnier than Trooping the Colour. And that's no small compliment.

But, of course, you know, in my time (quickly nurse . . .). *Graeme Garden*

Letters

IQ testing

Sir,—Many of your readers will have grown accustomed to the bizarre quality of debate around the subject of IQ testing. It is one which is conspicuous for the absence of accepted scientific discourse. Professor Eysenck's letter (28 June, p 832) aptly portrays this tradition of psychometry. The history of this area is the history of a chain of individuals fighting viciously from entrenched political positions against any criticism of their scientific pretensions. The teacher-pupil perpetuation of this tradition through Galton, Burt, Eysenck, and Jensen has preserved both its intellectual stance and its ideological commitment.

Cattell, one of the staunchest defenders of this line, once vituperated bitterly at the many critics who were "making holiday" in that area. He went on with greater resolve, and with the financial backing of the Eugenics Society, to compound the hereditarian position. By this time Alfred Binet's warnings against such distortions of IQ measures—and his advice to "protest and act against such brutal pessimism"—had long been forgotten. R. G. Collingwood, the eminent philosopher of the time, placed psychometry in the same league as alchemy and astrology—"though these at least kept up their pretensions of being scientific, with the former the pretension is dropped almost as soon as it is established".

With the question of race the psychometric literature is more slipshod, more pseudo-sophisticated and tendentious, and its proponents more defensive, than ever. Professor Eysenck, however, is the contemporary upholder of this quaint political tradition, and this explains his predictable reaction to any facts that may confuse the issue. Hence we see a characteristic example of the insecurity-aggression axis, with biased empirical reference and mystifying jargon. It also explains why Professor Eysenck has been busy of late disclaiming some of the basic premises of his position in order to give odious theories a human face. Alas, Race, Intelligence and Education, and other such writings, have been published, and readers must judge for themselves the belated apologetics of "Who? Me? I said no such thing."

Ken Richardson

National Child Development Study
National Children's Bureau
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Sir,—Professor Eysenck persists in waving the term "fact" like a fly-swotter. Even a basic understanding of the philosophy of science would prevent him from getting so repeatedly into these long non-arguments with Professor Rose, persons of the Freudian persuasions and others.

I don't imagine it worries the American blacks particularly that their IQs are as low as those of the Irish in Professor Eysenck's *opinion*.

Brendan McGann

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Ireland

Concorde characteristics

Sir,—Mr Nash-Webber (Letters, 5 July, p 40) seems to have confused the two issues of standard flight regimes and the instability problems of Concorde that I was referring to. May I quote briefly from the article in Flight International (29 April, 1971), to make this clear:

"Mr Corps . . . emphasises the criticalitay of flying a slender delta in this region (on take-off) where small decrements in speed mean large increases in drag. Perhaps the most important handling aspect of Concorde at low speed is the fact that it is flying on the back side of the drag curve—deceleration causes a drag rise."

The article contrasts Concorde with the 707, whose drag decreases on deceleration. Further on, we read: "Another thing Mr Corps thinks worth noting is the rather large drag effect of the undercarriage." This together with the penalty of a slender delta shape, produces the need for some 17 or 18 tons of thrust at 200 kt on a Concorde compared with only 5 or 6 on a 707. "This simply illustrates the fact that slender deltas are not meant to fly slow for very long and the lift/drag ratio for Concorde is down to about four while on a 707 at this point its lift/drag ratio is perhaps around 20."

These features, and others I omit for brevity, will establish that there is something special about Concorde's landing characteristics.

J. R. Ravetz

Department of Philosophy
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Lighthill's AI upheaval

Sir,—Professor Donald Michie is inconsistent in his argument that you mis-state the situation of artificial intelligence research (Letters, 14 June, p 710). He maintains that AI scientists cannot communicate their ideas adequately using language and symbols, but need a working computer model. In particular he needs a PDP-10 at public expense. Yet without such a model he and his colleagues at Edinburgh are "as familiar with the programming and data-base techniques used by Terry Winograd at MIT as are AI scientists anywhere else". While, without the benefit of an Elliott 4130 of their own, American AI scientists can know that "Edinburgh work . . . should be regarded as technically comparable with the leading US projects".

Of course this unique need of AI is nonsense. Professor Michie's demand for his own PDP-10 on which to run imported American software "as a precondition for (British AI) research to develop" can only mean to a reasonable human being that Lighthill was correct, and existing British AI is largely bankrupt.

But this is a minor argument, of interest only to those whose livelihood depends upon jostling around the public trough. The major implications of Lighthill, that AI scientists have given computer science a bad name because of their exaggerated claims and that they played into the hands of the computer manufacturers' PR men by using anthropomorphic terminology have remained unanswered in the flood of pro-robot propaganda emanating from Edinburgh.

Even more serious is the absence, in Professor Michie's reply to your article (Technology Review, 31 May, p 552), of any reference to the dangers described there as inherent in large computer programs. In the same issue as his letter you report American worries about an ABM project involving 13 linked computers and 3000 programmers (Feedback, 14 June, p 703). How many incidents are yet to occur, like the simultaneous destruction of 117 American weather balloons in September 1971, due to a large system programming error?

Perhaps Professor Michie does not have any worries about the social consequences of his work. If that is the case, he should let us know why!

Ian Benson

105 Plimsoll Road
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New Zealand marine reserve

Sir,—Jon Tinker's comments on Professor R. B. Clark's Working Party's report on Marine Wildlife Conservation (Comment, 8 March, p 522), and states that New Zealand has established a marine reserve. I wish it were true.

Attempts to establish a marine reserve were begun by Professor V. J. Chapman in late 1965 and draft proposals for legislation and a suitable area were put forward. The initial frustration was due to the lack of legislation under which a marine reserve could be set up. As a result of continual prodding, the government eventually formulated a Marine Reserve Bill which had the support, not only of marine biologists both in universities and government, but also of the NZ Underwater Association and some parts of the fishing industry. The Bill became law in September 1971. In October 1972 the University of Auckland formally submitted proposals for a marine reserve adjacent to its Marine Research Laboratory at Leigh. The application was accepted by the government in May, 1973 and on 1 June, 1973, the first advertisement of the application appeared in the national press. Objectors have until the end of July to submit their objections, and it is expected that these will come from the fishing industry, surf casting fishermen, and other members of the public who feel that their liberties are being curtailed.

F. J. Taylor

Marine Research Laboratory
University of Auckland
Leigh
New Zealand

Technology transferred

Sir,—Michael Kenward's interesting article on peak-load reserves for electrical generating systems ("Technology transferred," 5 July, p 26) implies that the only alternatives to the Dinoric pumped hydroelectric scheme are "gas turbines, and perhaps the more far out idea of pumped air storage".

Some of your readers—particularly the opponents of Dinoric—may be interested to hear of an even more far-out idea based on inertial energy storage (US Patent 3, 683, 216, R. F. Post). With the use of modern fibre composites and a novel approach to the design of flywheels, this system appears capable of reducing storage costs (compared with those of pumped hydroelectrics) by as much as 50 per cent—which, aesthetic and environmental benefits aside, could come to mean that it is surprisingly "near in".

R. A. Fitch

Maxwell Laboratories Inc
9244 Balboa Avenue
San Diego
California 92123

Lead in schools

Sir,—The use of lead compounds in schools leaves much to be desired when one considers that there is bound to be a long-term accumulation in dust in school laboratories.

Reading through the book published by the Nuffield Foundation, for children from first forms upwards, I came across 16 instances where it is necessary for lead components to be used by pupils in their experiments. For instance, red lead (Pb_3O_4) is heated to produce oxygen, litharge (PbO) is heated with charcoal to reduce it to metallic lead; there are other experiments using lead nitrate and carbonate.

Lead is by no means the only thing that may be considered dangerous. One finds cases where mercury (I) or mercury (II) oxide are used as well as asbestos.

Advocates of Nuffield Science may say that experiments using these substances are few and that there is relatively no danger. In my school there are five first-form chemistry sets, five second-form sets and so on. In each set there are about 17 pairs of children all doing the same experiment—a considerable volume of powdered lead compounds.

Being young and many of them not too bright, an understanding of the importance of care and cleanliness is not an easy thing to put over.

G. H. Woods

47 Brookdale
London N11 1BS

Medical climatology

Sir,—Neal Miller's troubles ("Rats' blood pressure," Monitor, 31 May, p 535) seem to be unusually baffling. Changes in handling or drug specification are more likely to produce a sharp discontinuity in the learning changes, rather than a progressive almost monotone decline. The pattern is suggestive of the variation of a worldwide independent variable, a situation by no means unprecedented in biological practice.

A number of biological, and even biochemical quantities are suspected of varying in parallel with the sunspot cycle. The Takata blood test is the most famous example. A small animal like the rat would probably be easily affected by subtle changes of this type. So if nothing else comes to light I hope Professor Miller has better luck with his experiments in a few years' time.

He may even have found a partial mechanism to explain the mysterious fluctuations in the populations of some animals associated with this cycle. See, for example, Professor George Piccardy's work on the chemical basis of medical climatology, part of the IGY programme.)

J. T. Benan

434 Upper Richmond Road W
Richmond
Surrey

Quasar redshift

Sir,—The statement that recent developments have strengthened the "straightforward interpretation" of the quasar redshift (Monitor, 12 April, p 73) overlooks considerable observational evidence to the contrary. Halton Arp of the Hale observatories has identified what he calls "associations" of quasars with certain galaxies, in which there are indications of a common origin. A recent mathematical analysis of the redshifts in the associations has demonstrated that the quasar redshift is a specific mathematical function of the redshift of the associated galaxy—see D. B. Larson's book Quasars and Pulsars (p 113). The existence of a fixed relationship of this kind helps to confirm Arp's conclusion that the quasars are "intermediate" rather than "cosmological" distances. The study by Bahcall and Hills that you mention as evidence in favour of the "cosmological" hypothesis is equally consistent with Arp's results.

Ronald W. Satz

12 Myrtle Avenue
Troy
New York 12180

Radiation risk

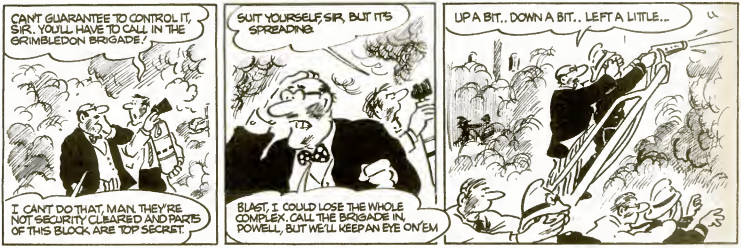
Sir,—In our advertisement (New Scientist, 5 July, p 37) a statement was made, and attributed to the National Radiological Protection Board, that "from a sample of 95 people, 28 were found to have damaged chromosomes". The qualification that the 95 were "suspected of over-exposure to radiation" was omitted. We are sorry that the copywriter's condensation produced this unfortunate error.

C. J. Simpson

Chapman & Hall
11 New Fetter Lane
London EC4P 4EE

Grimbledon Down

Bill Tidy


CAN'T GUARANTEE TO CONTROL IT, SIR. YOU'LL HAVE TO CALL IN THE GRIMBLEDON BRIGADE!
I CAN'T DO THAT, MAN. THEY'RE NOT SECURITY CLEARED AND PARTS OF THIS BLOCK ARE TOP SECRET.
SUIT YOURSELF, SIR, BUT IT'S SPREADING.
BLAST, I COULD LOSE THE WHOLE COMPLEX. CALL THE BRIGADE IN, POWELL, BUT WE'LL KEEP AN EYE ON'EM
UP A BIT.. DOWN A BIT.. LEFT A LITTLE...

CLASSIFIED ADVERTISEMENTS

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APPOINTMENTS AND SITUATIONS VACANT

RICE RESEARCH STATION ROKUPR

Vacancy for

DEPUTY DIRECTOR

RICE RESEARCH STATION, ROKUPR,

SIERRA LEONE

Applications are invited from suitable candidates for the above position.

Requirement:
A primary degree in Agriculture or Agricultural Science. A higher degree in Crop Science, Agricultural Economics and Extension or Agricultural Engineering. A minimum of 5 years post qualification experience. Candidates with high and proven professional calibre, preferably in rice work will be preferred. They should be capable of commanding the respect of station research staff as well as international research staff to be located at the station. (Applicants may enclose copies of relevant publications if available).

Duties:
To assist and deputise the Director in all matters relating to the planning and administration of the Station and will be expected to prepare, conduct and supervise such research projects as agreed upon in consultation with the Director.

Conditions of Service:
Consolidated salary—starting £3,250 per annum; car allowance of £150 per annum; 6 weeks annual leave; partly furnished house at nominal rent; contract gratuity of 15% salary contributed by the Station.

Applications:
Three copies of application giving age, marital status, details of qualifications and all relevant experience including the names and addresses of three referees should reach the **Secretary, Interim Committee, Rice Research Station, Rokupr, Sierra Leone,** before the 10th August, 1973. Applicants should request their referees to submit references directly to the Secretary, under confidential cover.

UNIVERSITY OF ESSEX DEPARTMENT OF CHEMISTRY

FELLOWSHIP
is available for work with Dr C. N. Davies under a Medical Research Council grant on the
INHALATION OF AEROSOLS.
The appointment is for one year in the first instance with the possibility of extension, to start not later than 1 September, 1973, at a salary of up to £2397 p.a. Candidates should be qualified in the Physical Sciences, Medicine or Physiology.

Further particulars are obtainable from the Registrar, University of Essex, Wivenhoe Park, Colchester, Essex, to whom applications (three copies quoting ref: PS/46/NS) should be made by 31 July, 1973.

Land Resources Development Overseas

£3562-£4665

The Land Resources Division of the Foreign and Commonwealth Office, Overseas Development Administration, undertakes integrated land resource appraisal, advises on planning for the development and use of these resources, and carries out or makes recommendations on feasibility studies relating to such development and use. This involves wide studies in agriculture and agricultural economics, as well as in all the other fields relevant to such a programme of work. Two posts are to be filled.

Agricultural Economist

You will be concerned primarily with collection, processing and analysis of agro-economic data relating to the structure and operation of the rural economy in the context of national economic development.

You must have 1st or 2nd honours in agricultural economics or in a related field such as agriculture, economics or rural sociology, with a post-graduate qualification in agricultural economics. Considerable relevant experience at a responsible level, some in developing countries, is essential. Knowledge of statistical techniques and familiarity with computer processing will be important.

Agriculturist

You will be principally involved in evaluation and improvement of existing farming systems; identification of possible new inputs, production practices and enterprises; assessment of research and extension operations; integration of livestock and crop production.

You must have 1st or 2nd honours in agriculture, or in natural science with a post-graduate qualification in agriculture. Considerable relevant experience at a responsible level in developing countries is essential.

Both these positions will normally be within a multi-disciplinary team, though you may sometimes be operating on an individual basis. You will be based at Tolworth, Surbiton, Surrey, but service overseas on field work for projects will form part of your duties. You may be seconded for selected work with overseas governments.

Both appointments are at the level of Principal Scientific Officer (£3562-£4665), and will normally be permanent, but candidates will, if their present employers agree, be considered for appointment to the Civil Service on secondment terms.

For further details and an application form (to be returned by 10 August 1973), write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone BASINGSTOKE 29222 ext 500 or LONDON 01-839 1992 (24 hour answering service). Please quote S/8308.

RARE EARTHS AND MEDICAL ELECTRONICS

Applications are invited from workers currently engaged in the science and technology of the Rare Earths and those engaged in the application of electronics, cybernetics and perception studies to medicine for appointment to the abstractors' panel of Rare Earth Bulletin and Medical Electronics and Communications Abstracts.

Details to J. M. D. G. Parry, Multi-Science Publishing Co Ltd, The Old Mill, Dorset Place, London E15 1DJ. Telephone 01-534 4882.

APPLIED SCIENTISTS/ ENGINEERS

Scientists with flair for innovation and proven ability to work on their own initiative are required by a broadly based R and D Company for interesting projects involving thin films, liquid crystals, miniature electronic systems and their reliability, transducers etc. Competitive salaries will be offered to successful applicants.

Contact: Mr. P. Norgate, G. V. Planer Ltd., Windmill Road, Sunbury-on-Thames, Middlesex, Tel. Sunbury 86262.

BIOCHEMISTRY DEPARTMENT

TECHNICIAN GRADE 6

Technician to assume full responsibility for undergraduate teaching laboratories and training of Junior Technicians. Minimum qualification H.N.C. or equivalent and 9-10 years' relevant experience. Salary £2404 on scale rising by £81 to £2890 including London Weighting.

Apply in writing giving full details of qualifications and experience to The Head Clerk (Ref: NS 101577), King's College London, Strand, WC2R 2LS.

AUSTRALIA
PUBLIC WORKS DEPARTMENT (VICTORIA)
PORTS AND HARBOURS DIVISION
ENGINEER OR SCIENTIFIC OFFICER (HYDRAULICS)

The ports and Harbours Division of the Public Works Department is responsible for the design, construction and maintenance of all harbours and coastal works in Victoria except for three limited areas controlled by local Harbour Trusts.

In connection with these works it operates a Marine Model Laboratory in Melbourne which is currently being expanded and a second large laboratory is proposed to study the effects of major industrial development in the nearby deep-water port of Westernport.

Substantial increase in laboratory personnel is proposed including the following position:—

PRINCIPAL ENGINEER (INVESTIGATIONS) or PRINCIPAL SCIENTIFIC OFFICER (INVESTIGATIONS)

Salary: $A13,195 (Engineer) or $A13,424 (Scientific Officer)

Duties: To be responsible for the supervision of the Department's marine model study programme including tidal, mobile bed and field studies associated with coastal and harbour hydraulic problems throughout the coastline of Victoria and the preparation of reports thereon. To supervise basic investigations into various aspects of port development and associated research.

Qualifications: An approved degree or diploma in civil engineering qualifying for admission to Graduate Membership of the Institution of Engineers, Australia or to the Institution of Civil Engineers, London or an approved tertiary qualification in a scientific discipline. Extensive experience in the type of duties stated is essential together with proven ability to control staff. Post-graduate research in this field would be an advantage.

Conditions include-

★ appointment to the permanent staff of the Victorian Public Service subject to medical examination.

★ contributory superannuation scheme.

★ liberal long service leave and other benefits, including cumulative sick leave.

★ promotion opportunities in the Public Works Department, and other Victorian Public Service Departments.

ENQUIRIES: Additional information may be obtained from the Office of the Agent-General in London.

NOTE: Successful married applicant will be eligible for reimbursement of 50% of removal expenses up to a maximum payment of $A750. Initial accommodation for married applicants will be available.

Written applications accompanied by documentary evidence of age, qualifications and experience should be forwarded to the Official Secretary, Office of the Agent-General for Victoria, Victoria House, Melbourne Place, Strand, London, WC2 4LG by 3rd August, 1973.

British Museum (Natural History)

Entomologist

■ Curate part of Orthoptera collection ■ Build up library of tape-recorded insect sounds ■ Taxonomic research, using stridulation, on group of Orthoptera.

□ Degree in Zoology □ Interest in insect sound □ Tape recording experience advantageous □ Age normally under 30 □ Appointment as Scientific Officer (£1493-£2352) or Higher Scientific Officer (£2251-£2842) according to age and experience □ Ref: SB/5/DK □ Closing date 3 August 1973.

□ Application forms from Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, telephone Basingstoke 29222 ext. 500 or London 01-839 1992 (24 hour answering service).

Department of the Environment
Princes Risborough Laboratory

Biologist

■ Research into causes and prevention of biodeterioration of material in buildings ■ Surveys of damage done by insects.

□ Degree or equivalent in Applied Biology or Biological Science □ Training or experience in use of quantitative techniques in Biology and/or materials protection an advantage □ Appointment as Scientific Officer (£1318-£2177) □ Age under 27 □ Ref: SA/19/HA □ Closing date 3 August 1973.

□ Application forms from Establishments Office, Princes Risborough Laboratory, Princes Risborough, Aylesbury, Bucks HP17 9PX.

Department of the Environment
Transport and Road Research Laboratory, Crowthorne.

Air Pollution Scientist

■ Study effects of pollutants from motor vehicles on road users ■ Measure pollutant levels inside vehicles ■ Produce controlled polluted atmospheres within rooms and vehicles ■ Assess effects of pollutants on driving ability.

□ 1st or 2nd honours degree in Chemistry □ 4 years' postgraduate experience preferably studying pollutants □ Age under 32 □ Appointment as Senior Scientific Officer (£2615-£3640) □ Ref: SA/3/HD □ Closing date 3 August 1973.

□ Application forms from the Director (Staffing Section), Transport and Road Research Laboratory, Crowthorne, Berks RG11 6AV, telephone Crowthorne 3131 ext. 2129.

Science group
CIVIL SERVICE

The South African Council for Scientific and Industrial Research

SCIENTIA
WNNR · CSIR

Director of oceanology institute

APPLICATIONS are invited for the post of Director of the proposed South African National Research Institute for Oceanology of the CSIR, which will be established with the appointment of the Director.

INITIALLY the new institute will consist mainly of the combination of the present CSIR activities in the field of Physical Oceanography (based in Durban), Civil Engineering Hydraulics (based in Stellenbosch) and Biological-Chemical Marine pollution.

THE ACTIVITIES of the Institute will include, amongst others, the following:

BASIC RESEARCH into various aspects of the Marine Science, the main purpose being to build up the necessary experimental and theoretical knowledge of the coastal regions and oceans around South Africa.

APPLIED RESEARCH in Physical and Chemical Oceanography (including studies of ocean waves and pollution):

APPLIED RESEARCH in the field of Civil Engineering Hydraulics (including research and development relating to coastal engineering, harbour development, river and estuary hydraulics and sediment transportation—techniques include field studies, analytical methods and hydraulic model studies):

STUDIES of the marine environment:

PARTICIPATION in the national programme of the South African National Committee for Oceanographic Research.

PARTICIPATION in interdisciplinary projects, co-operative projects with other organizations in the country, and in international research programmes and activities.

CO-OPERATION with other CSIR institutes and outside organizations on projects such as the establishment of a National Oceanographic Data Bank and the development and calibration of oceanographic instruments.

THE EXISTING FACILITIES which will be attached to the institute include the following:

A WELL-EQUIPPED RESEARCH VESSEL, the "Meiring Naude" with a crew of 5 Officers and 8 other crew members and accommodation for 8 scientists:

VARIOUS INSTRUMENTS for measuring physical quantities in the sea, including wave conditions and current velocities:

WELL-EQUIPPED LABORATORIES especially for work in the fields of Physical Oceanography, Hydraulics and marine pollution:

A LARGE HALL for movable and fixed-bed hydraulic models, with equipment such as wave-generators and a wind wave flume:

COMPUTER FACILITIES, including equipment for data acquisition and local processing as well as the computer centre which serves the CSIR, at present based on an IBM/360 model 65.

THE WORK OF THE DIRECTOR will include the following:

THE FURTHER PLANNING and extension —within the framework of the CSIR's policy—of the National Research Institute for Oceanology, with the relevant existing activities of the CSIR as a starting point.

BROAD PROFESSIONAL GUIDANCE in the institute in the field of marine sciences:

ADMINISTRATION of the staff, finances and work programme of the Institute, including contracts with outside sponsors.

APPLY in full before 1st August 1973 to the Office of the Scientific Counsellor, Chichester House, 278 High Holborn, London WC1V 7HE. Tel: 01-242 9641

THE ANIMAL HEALTH TRUST

Small Animals Centre
Lanwades Park, Kennett,
Newmarket, Suffolk
Tel: Newmarket (0638) 750543

CANCER RESEARCH

Applications are invited from graduates for a research post at the Small Animals Centre which is being provided from a grant from the Cancer Research Campaign for research into the aetiological factors associated with mammary carcinoma of the dog and cat.

The successful candidate is likely to have had, or be prepared to gain experience in immunology and tumour virology.

Salary Scales: £1476 x 69 to £1959; plus FSSU. £2100 x 102 to £2508 (bar) plus FSSU.

It is likely that the research project will continue for a period of not less than three years, subject to satisfactory progress.

Forms of application and further details of the appointment may be obtained from the Chief Executive Officer, Animal Health Trust, 24 Portland Place, London, W1N 4HN.

Charing Cross Hospital (Fulham)

ELECTRONIC TECHNICIAN FOR ELECTRICAL SAFETY DUTIES

Candidates for this newly created post, must possess a qualification equivalent to at least HNC in Electrical/Electronic Engineering, and must have an extensive knowledge of electronic equipment, not necessarily in the field of medical electronics. Salary on scale £1977–£2508 plus £126 p.a. London Weighting.

Application form and full job description obtainable from **Mr. C. J. H. Hill, Personnel Department, Charing Cross Hospital (Fulham), Fulham Palace Road, London W.6., telephone 748 2050, ext. 2992, to be returned by 1st August.**

UNIVERSITY OF MANCHESTER

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Applications invited from Honours graduates or those graduating this year in Electrical Engineering, Physics, Mathematics or Chemistry to undertake research in the following areas: Simulation and Automatic Control of Large Alternators and Power Systems; Investigation of Optoelectronic Materials and Devices; Magnetic "Bubble" Domain Research which includes Theoretical Analysis, Material Preparation and Computer Memory Device Development; Hybrid Logic Simulation; Absolute Measurements based on Atomic Constants; Electronic Instrumentation; Miniature Motors utilising Integrated Electronic Drive and Control. S.R.C. studentships for the above work are tenable from September 1973. Successful candidates will be expected to register for a higher degree. Applications as soon as possible to Professor G. R. Hoffman, Department of Electronic and Electrical Engineering, The University, Manchester, M13 9PL, with details of qualifications, experience and research interests.

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MEDICAL RESEARCH COUNCIL

The Council, which is the main government agency for the promotion of medical research, has vacancies at its headquarters office in London for men and women to undertake duties:—

1. In a small group providing secretariat services for the Council and four of its Boards concerned with research in the clinical, biological, tropical medicine and cancer fields. The continuing commitments of the job are assisting the Board secretaries and liaising with other sections of the office in the preparation of Board and Council papers. To this is added a varying amount of brief-writing, minute-taking and ad hoc jobs as the need arises. A good educational background is required, and the ability to write clearly.
2. As an EDITORIAL ASSISTANT in the small publications group. Candidates for this post should also have a good educational background and the ability to write clearly.

Those appointed to both posts would have the opportunity of moving to other work within the headquarters office with subsequent promotion opportunities.

Salary will be in the range £1388 (age 21) to £2463, depending on age, qualifications and experience; annual leave 20 days; superannuation provision and salary supplement; appointments subject to a probationary period of one year.

Please write or telephone Mrs Anne Edwards, Medical Research Council, 20 Park Crescent, London, W1N 4AL (01-636 5422 Ext. 300) quoting reference E2/546 for an application form, which should be returned by 25 July, 1973.

SENIOR INSTRUMENT TECHNICIAN

A skilled Technician is required for the FERMENTATION DEPARTMENT at the main Research and Development Laboratories for the Ranks Hovis McDougall Group. He will assist in equipment specification, procurement and installation, and will take charge of the maintenance of electronic, electric and pneumatic instrumentation.

Applicants should have at least HNC qualifications in a relevant subject and several years experience in industrial instrumenation, preferably on electronic equipment.

Salary will be negotiable from £2,000 per annum. The Centre has a high reputation for its working environment and facilities.

Please write with information on qualifications and experience quoting ref: F/328 to the Assistant Director (Admin.), RHM Research Ltd., The Lord Rank Research Centre, Lincoln Road, High Wycombe, Bucks HP12 3QR.

THE KENNEDY INSTITUTE

DIVISION OF CELLULAR BIOLOGY

RESEARCH ASSISTANT

required for one year, in the first instance, to work on the cytochemistry of bone and the effects of fracture.

Salary, depending on age, experience and qualifications, on the Whitley Council Junior Technician/Technician scale. Written applications, giving full details and naming two referees, to the Laboratory Superintendent, Kennedy Institute of Rheumatology, Bute Gardens, London, W6 7DW.

Assistant Statistician

An Assistant Statistician is required at Jealotts Hill Research Station (ICI's main centre for agricultural and biological research).

He/She will join a team led by a senior statistician; he will help to advise in experimental design, and will plan, carry out and report on statistical analyses of experimental results, with the help of an assistant.

He may also take part in independent biometric studies carried out by the team. An IBM 1130 computer is installed, with on-line access to an IBM 360/65.

The ideal applicant will have academic qualifications in statistics, including experimental design, together with experience of applying statistical methods to scientific data and of supervising junior staff. He will have some knowledge of computer techniques and Fortran programming.

The successful candidate in the age range 25–35 will not necessarily be a graduate: interest, experience and practical understanding of statistical principles will carry equal weight as academic qualifications.

Applicants should apply in writing to:

Mr S. R. Stephenson, Personnel Officer
I.C.I. Plant Protection Ltd., Jealotts Hill Research Station, Bracknell, Berkshire.

ICI **Plant Protection Limited**

THE LONDON HOSPITAL MEDICAL COLLEGE

(UNIVERSITY OF LONDON)

Department of Oral Pathology Tissue Culture Unit

TECHNICIAN, male or female, required to assist research project, including histochemistry and tissue culture. Candidates must have obtained H.N.C., City & Guilds or equivalent qualification although consideration would be given to those who have not completed their course. Salary according to qualifications and experience within the Whitley Council Scales for Medical Laboratory Technicians within the range £1,335/£1,725 plus £126 London Weighting per annum (subject to upward revision). Enquiries to Professor A. E. W. Miles (tel. no. 01-247 5454 Ext. 89). Applications in writing to the Secretary, The London Hospital Medical College, Turner Street, London, E1 2AD, quoting reference OP/6/73.

CHELSEA COLLEGE

University of London

POSTDOCTORAL RESEARCH ASSOCIATE TO WORK ON PATTERN RECOGNITION

Applications are invited for a post available as part of a project financed by the S.R.C. on the classification of biological material. An automatic microscope has been built which extracts information in digital form from the field of view. The person appointed would be involved in the development and application of computer techniques for processing the data. The post runs until 31 December, 1975, and applicants should have appropriate and relevant experience at the doctoral level. Salary in the range £1926—£2241 per annum. Enquiries or applications together with curriculum vitae and names of two referees should be addressed to Dr D. Rosen, (NS) Biophysics Laboratory, Chelsea College, Manresa Road, London, SW3 6LX.

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

Materials Engineering

Applications are invited for a

Senior Lectureship and a Lectureship

in the Department of Materials Technology. Areas of work will include development of the undergraduate course in Materials Engineering and postgraduate developments in various aspects of Materials Technology.

The senior post is largely, but not exclusively, concerned with the development of the M.Sc. course in Materials Protection and research in this field. Extensive teaching and research experience in coatings science and technology is required. Candidates for the lectureship should have interests in materials fabrication especially electroforming, coated materials, and finishing processes. A knowledge of paint and polymer films and polymer fabrication processes would be an advantage. The appointee to this post may be required to spend part of his time in the Midlands Institute of Design and Production within the University.

The salaries for these posts are within the scales £4,143–£5,247 for the senior post and £1,764–£4,299 for the lectureship. Postcard requests for further details and application forms to Assistant Registrar (Establishment) ref 73/42 (L) or (SL).

Loughborough Leicestershire

UNIVERSITY OF BIRMINGHAM

Faculty of Science and Engineering

CHUBB RESEARCH FELLOWSHIP

Applications are invited for the above post-doctoral Fellowship, which will normally be held in the Department of Mechanical Engineering, Civil Engineering, Physical Metallurgy and Science of Materials or Industrial Metallurgy, but may be held in any other department of the Faculty. The holder will be required to undertake research within the broad field of interest of Messrs., Chubb and Sons Lock and Safe Company, under the formal direction of the Head of the Department. Salary:- £1,764-£2,079 + F.S.S.U. (under review).

Applications (4 copies) with the names of three referees by 21st July, 1973, to the Assistant Registrar (S), University of Birmingham, P.O. Box 363, Birmingham B15 2TT, from whome further information may be obtained. Please quote ref. NF1.

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URBAN PLANNING

-team leaders for scientific research

The Building Research Establishment, Garston, Watford, which is concerned with all aspects of structural and environmental research and development, is expanding its activities in urban planning. This creates the need for two team leaders, each to head a small multi-disciplinary research group on projects in new areas of work:

Centres of employment

Research will relate to the location and scale of provision of centres of employment within towns. The aim is to provide planners and policy makers with information and methods by which they can predict the outcome of planning proposals and judge between alternatives.

The built environment

The object is to identify the factors that determine the environment around buildings and within urban areas. Research will involve devising methods for their measurement, investigating their relative importance and determining the ways in which they contribute to the totality.

You should have a first or second class honours degree in mathematics, physics, sociology or economics, or an equivalent qualification, for instance, in planning. You must have considerable relevant research experience at a responsible level, and the ability to resolve complex and inter-related research problems, working from time to time with planning organisations in the Department of the Environment and outside it.

Appointments will be made at the level of Principal Scientific Officer, (starting salary within the range £3472 – £4575 pa). There are promotion prospects and a non-contributory pension scheme.

For further details and an application form (to be returned by 1 August 1973), write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB or telephone Basingstoke 29222 ext 500 or London 01-839 1992 (24 hour answering service). Please quote S/8311.

bre

MICROBIOLOGIST

Gala Cosmetic Group Limited need a microbiologist to supervise the micro-testing of cosmetic bulk and raw materials. Based at their Quality Control Department in Surbiton, the person appointed will be mainly responsible for evaluating preservative systems and advising on general sanitation and hygiene.

This position would be ideal for a male or female graduate, aged 25-35, with previous experience of the cosmetics industry or food control. An attractive starting salary according to age and experience will be paid and conditions within the company are excellent.

Phone or write to:

T. G. O'Brien, Gala Cosmetic Group Ltd., Surbiton, Surrey. 01-397 5200.

JUNIOR TECHNICIAN. Young man required to assist in laboratory concerned with endocrinological studies. Suitable for school leaver interested in a career in biological research. Salary in the range of £717 to £1155 plus £175 London weighting per annum. 37½ hour week, three week's annual leave. Applications in writing to Departmental Superintendent, Department of Biochemistry, Imperial College, London SW7 2AY.

Occupational Hygienist

Portsmouth £3472-£4575

This is an opportunity to join the Institute of Naval Medicine, Alverstoke, Portsmouth, as adviser to the Royal Dockyards and other establishments on all matters of occupational hygiene. The work will involve building up an efficient organisation to identify and evaluate overt and potential health hazards in the working environment.

The Institute has a complete range of supporting laboratory services, and maintains a close liaison with relevant university departments and other institutions. The Occupational Hygienist will play an important role in the many research projects now in progress, and be encouraged to undertake individual research using the excellent experimental facilities. He, or she, will also assist in the Institute's extensive programme of post-graduate education.

Candidates should normally have a first or second class honours degree in Engineering, Physics or Chemistry, and a post graduate qualification in Occupational Hygiene. Experience of naval engineering or similar industrial work would be an advantage.

The starting salary may be above the minimum on the scale £3472 to £4575. Promotion prospects. Non-contributory pension scheme. 5 weeks annual leave.

For full details and an application form (to be returned by 2 August 1973) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB or telephone BASINGSTOKE 29222 ext. 500 or LONDON 01-839 1992 (24 hour answering service), quoting S/8313/3.

SENIOR ANALYTICAL ASSISTANT

Is required in our Ipswich Research Department to assist the Senior Development Chemist. The job will include investigations into the suitability of raw materials for use in livestock feeding stuffs, the analyses of body fluids and the introduction of new analytical techniques.

We expect the successful candidate to be over 21 and to hold an ONC, HNC, or similar qualification. Broad analytical experience is important, possibly in a consultant laboratory or with foodstuffs analysis.

The rewards include a competitive salary, annual bonus, good fringe benefits and the opportunity of working with minimum supervision in excellent conditions.

Interested? Please write to Mr C. A. Best, Group Personnel Department, Pauls and Whites Ltd, PO Box 39, Key Street, Ipswich IP4 1BX Suffolk, telephone Ipswich (0473 56711).

PAULS

UNIVERSITY OF WARWICK

POSTDOCTORAL FELLOWSHIP IN BIOLOGICAL SCIENCES

Applications are invited for the above post to work on the biochemistry of the replication of virus RNA. The post would be suiable for a biochemist with an interest in animal virology or a virologist with a good knowledge of biochemistry. Experience with techniques for the extraction and analysis of RNA would be an advantage. The appointment is for two years commencing 1st October 1973. Salary in the range £1,929 x £129-£2,058 p.a. with FSSU. Further details and application forms may be obtained from the Academic Registrar, University of Warwick, Coventry CV4 7AL, quoting Ref. No: 48/2L/73. Closing date for receipt of applications is 31st July, 1973.

Find your place in British Gas

PLANNING OFFICER FOR R&D

up to £3027

A Planning Officer is required to complete the team in the recently formed R&D Planning Section at British Gas Headquarters.

The Planning Officer will assist in implementing and operating the planning process for the £7 million pa British Gas R&D programme. In addition he (or she) will take part in the co-operative development within R&D Division of improved methods for the planning, evaluation and control of R & D effort, and for resource allocation between competing areas of work.

Applicants should be graduates, numerate, with appreciation of relevant technology, and with a good grounding in statistics and economics. A management science qualification would be an advantage. Some experience of working in industry is necessary, and familiarity with an R&D environment would be useful. Candidates should have an interest in both the planning and the administrative sides of the job.

Salary will be in the range £2367-£3027 (currently under review). The position is based at High Holborn, London, but will involve occasional travel within the UK.

Application forms can be obtained from the Personnel Manager, British Gas, 59 Bryanston Street, London W1A 2AZ, quoting reference RD/500/320/NS. Closing date for applications 26th July.

BRITISH GAS

MICROBIOLOGICAL ASSISTANT

A vacancy exists for a female assistant in our Microbiological Department for varied and interesting work associated with fermentation processes. Part of this work will involve the comparison and identification of micro-organisms.

Applicants should possess an H.N.C. in Microbiology or its equivalent.

Write, giving details of previous appointments, age, experience and present salary to:-

The Manager, Microbiological Department,

STURGE CHEMICALS

JOHN & E. STURGE LTD.,
Denison Road,
SELBY, Yorkshire.
YO8 8EF.

Research Fellowships

for a fixed period of 3 years, are available at the Royal Military College of Science, Shrivenham, Wiltshire as follows:

Civil Engineering

Development of a new type of high strength end joint for timber. Candidates should preferably have experience of stress analysis and materials testing, or training in an allied discipline. Experience with timber would be an advantage.

Electrical Engineering

Investigation of the physical limitations of electrical machines (e.g. power and speed) and the way in which these limitations may be overcome by use of semi-conductor devices.

Electronic Engineering

Work on (a) active and passive antenna synthesis and design or (b) signal processing, speech coding, and feedback communication or computer simulation of communication system performance.

Operational Research

Military OR, including study of conflict models, search theory, theory of games and resource allocation. Relevant experience is desirable. Candidates should preferably have a degree in science, mathematics or statistics but economics and human/social science graduates will be considered if they have proven experience in operational research.

Physics

Study of basic radiation mechanisms in materials. Candidates should have considerable experience of E.s.r. and/or NMR equipments and preferably also of solid state organic materials.

Chemistry

Research into the photochemistry and electrochemistry of organic compounds.

Appointment will be as Senior Research Fellow (£2460–£3100) or Junior Research Fellow (£1670–£2195) according to qualifications and experience. Accommodation in a Hall of Residence is available for single male staff.

Candidates must have a 1st or 2nd class honours degree, or an equivalent qualification, in an appropriate subject and at least 2 years' postgraduate research experience (3 years' for a Senior Fellowship).

For an application form (to be returned by 3 August 1973) contact the Registrar, Royal Military College of Science, Shrivenham, Wiltshire, telephone Shrivenham 782551. Please quote SC/1/EP/1.

PROCUREMENT EXECUTIVE,
MINISTRY OF DEFENCE

UNIVERSITY OF DAR ES SALAAM—TANZANIA

Applications are invited for (a) SENIOR LECTURESHIP or (b) LECTURESHIP IN AGRICULTURAL ENGINEERING. Applicants must possess a good basic degree in Agricultural/Civil Engineering or Agriculture and a Master's degree in Agricultural Engineering. Preference will be given to those who have specialised in Farm Structures. Considerable teaching experience at University level is essential. Research experience and the ability to supervise post graduate research is desirable. Appointee will assist in the continued development of the Department of Agricultural Engineering and Land Planning and teach courses in Agricultural Engineering and conduct research in the department. He will also be expected to supervise postgraduate programmes. Salary scales: (a) T£2,380—T£2,800 p.a. (b) T£1,898—T£2,318 p.a. (T£1=£1·13 sterling). The British Government may supplement salary in range £550—£950 p.a. (sterling) for married appointee or £300—£650 p.a. (sterling) for single appointee (normally free of all tax) and provide children's education allowances and holiday visit passages. FSSU. Family passages; biennial overseas leave. Detailed applications (two copies), including a curriculum vitae and naming three referees, should be sent by air mail, not later than 6 August, 1973, to the Chief Academic Officer, University of Dar es Salaam, PO Box 35091, Dar es Salaam, Tanzania. Applicants resident in UK should also send one copy to Inter-University Council, 90/91 Tottenham Court Road, London, W1P 0DT. Further particulars may be obtained from other address.

KINGS
College Hospital Group

Looking for a post which requires commitment as well as technical skill? The E.E.G. Department at King's College Hospital offers candidates with either ONC, GCE, HNC exams or a Science Degree a challenging opportunity to participate in Medical Technology. Salary according to qualifications.

Please write or phone the
Assistant Hospital Secretary
King's College Hospital
Denmark Hill
London, SE5 9RS
Tel: 274 6222, extension 2408

RECENT GRADUATE,

preferably in physics, required as editorial assistant for instrument physics journal. Salary from £1380 p.a. Apply to **Executive Editor, Institute of Physics, 1 Lowther Gardens, Prince Consort Road, London SW7 2AB. (Tel: 01-589-0048).**

EUROTHERM LIMITED

require

SENIOR ELECTRONIC ENGINEERS

Experience desirable in one of the following:

Low level, low drift analogue design
Digital circuit design
Solid state power engineering
Digital systems for process control

We are a well established but rapidly growing British company in the field of industrial electronic controls—temperature, motor and process controls. We maintain a high standard of design, consciously aiming to produce products which are amongst the best in the world in their sphere; over half our production goes overseas.

Our designers contribute to, and participate in our success to the fullest extent—several are DIRECTORS and SHAREHOLDERS. The men we seek will have a rigorous theoretical background, and probably a higher degree.

Our immediate vacancies will probably be of particular interes to experienced UNIVERSITY TEACHING OR RESEARCH STAFF who would like a position where their intellectual abilities will be both appreciated and adequately rewarded in a congenial, thinking yet fast moving environment.
We have vacancies in two locations

LEWES, SUSSEX

where our main development laboratory is located, and at

RESTON, VIRGINIA, U.S.A.

with our very successful American subsidiary, located in an extremely pleasant semi-rural part of America. The American posts can either be permanent or, by arrangement, a two or three year term in America, subsequently returning to our Lewes R & D laboratory.

If you are interested, please write to T. L. Martin, Managing Director, to arrange an informal discussion.

Eurotherm Limited, Broadwater, Worthing, Sussex.

UNIVERSITY OF STRATHCLYDE

DEPARTMENT OF ELECTRICAL ENGINEERING
CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH FELLOWSHIP AND RESEARCH STUDENTSHIP

Applications are invited for appointment to a Research Fellowship and a Research Studentship tenable in the above Department for research in high voltage engineering. The C.E.G.B. research group, consisting of a Fellow supported normally by three Research Students, is responsible for a co-ordinated programme of work on the insulation properties of high pressure gas systems including breakdown along insulator surfaces, and is supplementary to a strong research group presently working broadly on discharges in gases, vacuum and solids.

The C.E.G.B. Fellowship will be awarded for three years in the first instance from 1st October 1973, and applicants should hold a higher degree in Electrical Engineering or in Physics. The Fellow will be expected to assist in supervising the research students of the group, and may be asked to give occasional lectures. Starting salary will be up to £3,510 per annum according to qualifications and experience, with F.S.S.U. benefits.

C.E.G.B. Research Studentships are awarded to candidates normally under the age of 25 who hold a good honours degree, and candidates are required to register for a PhD, degree. The awards are tenable for three years from 1st October, subject to annual review, and will have a value in the range £650–£775 per annum with supplementary allowances for dependants.

Applications (quoting R18/73) with curriculum vitae and the names of two referees, should be sent to **Professor D. J. Tedford, Department of Electrical Engineering, University of Strathclyde, Royal College Building, 204 George Street, Glasgow, G1 1XW to arrive not later than 21st July, 1973.**

UNIVERSITY OF BOTSWANA, LESOTHO AND SWAZILAND

Applications are invited for (a) LECTURESHIP or (b) ASSISTANT LECTURESHIP IN AGRICULTURAL EXTENSION in Faculty of Agriculture, Luyengo, Swaziland. Applicants should hold an Agriculture degree with considerable experience of Agricultural Extension work. A postgraduate qualification in Extension or Education, and experience of teaching at University level will be an advantage. Duties will consist of teaching diploma and degree students in Agriculture, providing liaison between research and extension services and conducting research in the field of Agricultural Extension.

Appointments will be on contract for limited periods, usually two years in the first instance. Salary scales: Lecturer R2,700—R4,560 p.a. Assistant Lecturer R2,292—R2,802 p.a. (£1 sterling=R1.73). The British Government may supplement salary in range £350 to £600 p.a. (sterling) for married appointee or £125—£250 p.a. (sterling) for single appointee (normally free of all tax) and provide children's holiday visit passages. Car and education allowances; medical scheme; accommodation at reasonable rents. Family passages; biennial overseas leave. Detailed applications (two copies), including a curriculum vitae and naming three referees, should be forwarded by air mail, not later than 16 August, 1973, to the Registrar, University of Botswana, Lesotho and Swaziland, Roma, Lesotho Africa. Applicants resident in UK should also send one copy to Inter-University Council, 90/91 Tottenham Court Road, London, W1P 0DT. Further particulars of these appointments may be obtained from either address.

INNER LONDON EDUCATION AUTHORITY

NORWOOD TECHNICAL COLLEGE

Main Building, Knight's Hill,
SE27. OTX

Department of Natural Sciences

Lecturer Grade I in Geology required from 1 September 1973, or as soon as possible thereafter. Applicants should possess teaching, industrial or research experience preferably in the field of Sedimentology. The person appointed will be expected to teach some B.Sc. and GCE 'A' Level work but will be particularly required to instruct in the training of geological techniques.

Salary Scale in accordance with the Burnham (FE) Report: Lecturer Grade I: On an incremental scale within the range £1660-£2685 (plus London allowance £118), starting point depending upon qualifications, training and experience. The maximum will be extended by two increments of £81 for good honours graduates.

Assistance may be given towards household removal expenses.

Application forms returnable within 14 days of the appearance of this advertisement, obtainable from the Clerk to the Governors. Enclose self addressed foolscap envelope.

UNIVERSITY OF CAMBRIDGE

Research assistant required to join project on organo-metallic compounds. Candidates should have an honours degree in Chemistry, or an HNC and some experience in preparative chemistry. Salary scale from £1593 at age 23. Further details from and applications to Dr. B. F. G. Johnson, University Chemical Laboratory, Lensfield Road, Cambridge CB2 1EW.

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THE GRASSLAND RESEARCH INSTITUTE

Hurley, Maidenhead,
Berkshire SL6 5LR

Two ASSISTANT SCIENTIFIC OFFICERS are required in the Biochemistry Section of the Department of Feed Evaluation and Ruminant Nutrition. The work comprises chemical, biochemical and radiobiological assays on feeds, digesta and physiological fluids and is closely integrated with animal nutrition and production studies. An interest in ruminant nutrition and previous experience in a chemistry laboratory are desirable but not essential.

Minimum qualifications:—4 GCE "O" levels, one of which must be English Language and one Maths or a Science.

Salary:—on age scale, eg £844 pa (age 18), £959 pa (age 19), £1077 pa (age 20), £1198 pa (age 21), £1397 pa (age 25 or over at entry) plus 5½ per cent superannuation allowance to offset personal contributions to optional scheme. Four weeks holiday per year. Sports and Social Club.

Applications to the Personnel Officer quoting reference 5/K/40 by 19 July 1973.

LIVERPOOL POLYTECHNIC

School of Pharmacy

ANIMAL HOUSE TECHNICIAN—T.4.

Duties include the breeding and maintenance of a variety of laboratory animals. Applicants should possess the Associateship of the Institute of Animal Technicians.

Salary Scale: £1,530—£1,803 per annum.

Details available from Staff Office, Dept. NS, Liverpool Polytechnic, Richmond House, 1 Rumford Place, Liverpool L3 9RH.

UNIVERSITY OF WARWICK

POSTDOCTORAL FELLOWSHIP IN BIOLOGICAL SCIENCES

Applications are invited for the above post to investigate the control of interferon production. The post would be suitable for a biochemist with an interest in cellular control systems or for a virologist with a good knowledge of biochemistry. Experience with cell-free systems would be an advantage. The appointment is for two years with salary up to £2,388 x £165-£2,553 p.a. with FSSU. Further details and application forms may be obtained from the Academic Registrar, University of Warwick Coventry CV4 7AL, quoting Ref. No 48/L/73. Closing date for receipt of applications 6th August, 1973.

COUNTY BOROUGH OF LUTON

SENIOR TECHNICIAN

£1,530-£1,803

Required to manage Biology Laboratories at Luton College of Technology. Previous experience of this work essential. Expertise in animal husbandry, histology and histochemistry preferred.

100% Removal Expenses.

Application forms, returnable by the 30th July, 1973, may be obtained from the Establishment Officer, Town Hall, Luton, LU1 2BQ.

Assistant Scientific Officers

The Department of Employment has vacancies for Assistant Scientific Officers with **HM Factory Inspectorate, Cricklewood, London, NW2** in the Industrial Hygiene Laboratory and in the Noise and Vibration Unit Laboratory; and with the **Employment Medical Advisory Service, Bayswater London, W2** in the Central Reference Laboratory.

Industrial Hygiene Laboratory

The duties include the sampling and analysis of toxic dusts, gases and vapours. Candidates should preferably have experience of chemical or physical methods of analysis and have worked in a chemical or physical laboratory or an associated workshop. Must be able and willing to learn new methods. Occasional travel within the UK.

Noise and Vibration Unit Laboratory

The duties include the calibration and maintenance of a wide range of noise and vibration measuring equipment and using this equipment on site as well as in the laboratory. Candidates should preferably have some knowledge of the maintenance and operation of electro-acoustical instruments.

Central Reference Laboratory

The duties are varied and unusual and mainly concerned with the examination of biological samples from industrial workers, an aptitude for working with, or an interest in electronic laboratory equipment, such as spectrophotometers would be an advantage. Some knowledge of chromatography and/or electrophoresis would also be desirable. Candidates should preferably have had experience in the Chemical Pathology Department of a hospital.

Candidates for all the posts must be over 16 and normally under 26 years of age.

Qualifications

The minimum qualifications required are passes in 4 distinct subjects in GCE or equivalent. The passes must include English, or English Language and a Science and Mathematical Subject. Other acceptable qualifications are an ONC (candidates must have successfully completed the 01 year); the intermediate examination of the Institute of Medical Laboratory Technology and Science Laboratory Technician's Ordinary Certificate.

Salary £675–£1,612 per annum according to age plus £90 per annum outer London allowance for Cricklewood posts and £175 per annum inner London allowance for Bayswater post.

Holidays

Four weeks rising eventually to six.

How to apply

Application form from Mr. C. H. Acres, Department of Employment (EST B3c) 12 St. James's Square, London SW1Y 4LL. Closing date for receipt of applications July 27, 1973.

DE Department of Employment

RESEARCH TECHNICIAN required to assist in research into the control of gene expression in eucaryotic organisms, involving routine protein purification techniques, preparation of DNA and subsequent analysis of RNA synthesised in vitro. It is hoped that some tissue culture will be carried out. Degree in biological sciences or biochemistry desirable but not essential. Salary in the range £1765-£1918 including London Weighting. Applications, including a complete curriculum vitae, to Dr. P. H. W. Butterworth, (NS) Department of Biochemistry, University College London, Gower Street, London, WC1E 6BT as soon as possible.

UNIVERSITY OF NEWCASTLE UPON TYNE

School of Physics

OPPORTUNITIES FOR RESEARCH STUDENTS

Applications are invited from graduates with a first-class or upper second degree in mathematics, physics or geology to take part in various research projects in the Department of Geophysics and Planetary Physics.

Applications should be sent as soon as possible to Mr. W. F. Mavor, School of Physics, The University, Newcastle upon Tyne NE1 7RU.

UNIVERSITY OF BASRAH

ACADEMIC APPOINTMENT

Applications are invited for the following posts:

Lecturers, Assistant Professors and Professors in the College of Science. 1. Department of Mathematics: (a) Mathematical Statistics (b) Applied Mathematics (c) Pure Mathematics.

2. Department of Physics: (a) Theoretical Physics (b) Electronics (c) Astronomy (d) Meteorology (e) Thermophysics.

3. Department of Biology: (a) Marine Biology (Oceanography) (b) Limnology (c) Biology.

4. Department of Chemistry: (a) Biochemistry (b) Industrial Chemistry (c) Physical or Analytical or Organic Chemistry.

Qualifications required: All applicants should have a PhD, Membership. Fellowship or equivalent degree. Teaching experience, research and published work will be in consideration for the placement of the applicant.

Salaries: Good salaries and benefits will be paid according to experience and qualifications. Informaton will be supplied on request.

Applications: Enquiries should be addressed to: CULTURAL RELATIONS OFFICE, UNIVERSITY OF BASRAH, BASRAH, Iraq.

GUY'S HOSPITAL MEDICAL SCHOOL

TECHNICIAN

required to assist in the supervision of the Animal Operating Suite and ancillary services. The unit has two well equipped operating theatres and undertakes a wide range of surgical procedures including major cardiovascular work. There are comprehensive laboratory facilities and modern animal accommodation. The installation of a sophisticated cine X-ray machine is in hand. Applicants must have experience and ability in the use and maintenance of physiological measurement equipment.

The post offers good career prospects. Salary in the range £1335-£2154 plus £126 London Weighting for applicant with HNC, AIMLT or equivalent. A student studying for these qualifications might be suitable.

Apply in writing, giving details of qualifications and experience, to the Secretary, Guy's Hospital Medical School, London Bridge, SE1 9RT, quoting Ref. AOS.

BIRKBECK COLLEGE

(University of London)

RESEARCH ASSISTANT

Department of Crystallography

A Research Assistant is required to join the Protein Section of the Chrystallographic Department to assist in research into the large scale purification of enzymes. Opportunities to participate in X-ray crystallographic work exist. Possession of experience in kinetics, purification techniques and the general handling of enzymes would be advantageous.

Appointment will be for a maximum period of three years: salary in the range £1350-£2079 with entry point related to age, experience and qualifications. Application forms and further details obtainable from the Deputy Secretary, (NS) Birkbeck College, Malet Street, London WC1.

EDUCATIONAL

Required in September, someone to teach Science at St. Christopher's School, 33 New Church Road, Hove, BN3 4AD. Telephone: Brighton 735404 or Brighton 738680.

UNIVERSITY OF BIRMINGHAM

Department of Geology

ANTARCTIC MARINE GEOPHYSICS

Applications are invited for two new posts with a N.E.R.C. sponsored and well established departmental research group investigating the structure and origin of the Scotia Sea, Antarctica. The group is university based and cruises of 4-5 months' duration take place in alternate years, the next being due in November 1973. Appointments will be for two years in the first instance with a strong probability of extension.

RESEARCH ASSOCIATE

Duties will be mainly to assist with seismic refraction and reflection profiling studies. Applicants should have a postgraduate qualification in geophysics and preferably experience in the marine field. Initial appointment at £1,419-£2,079 + F.S.S.U. (under review).

RESEARCH ASSISTANT

Duties will be mainly to assist with data acquisition at sea, with subsequent processing and preparation of maps and diagrams. Geophysical and marine experience an advantage. Salary:- £990-£1,404 (from 1.10.73).

Applications, together with the names and addresses of 3 referees should be sent to the Assistant Registrar (Science and Engineering), The University of Birmingham, P.O. Box 363, Birmingham, B15 2TT, before 21 July. Please quote ref. NX1.

RESEARCH STAFF

with good honours degrees or equivalent required for new Wantage laboratories of important industrial research and development organisation:-

Chemist or Metallurgist for corrosion researches with opportunity to assist in consultancy. A sound electrochemical knowledge and engineering aptitude are required. Preferred age up to 25 years approx. Ref. AC26.

Physical Metallurgist capable of exploiting in depth the relationship between constitution and properties of materials for work on new alloys and applications. Practical experience of modern techniques of examination and testing an advantage. Preferred age up to 30 years. Ref. AC27.

Metallurgist for investigations of mechanical properties preferably having practical experience of fatigue and fracture mechanics. Preferred age up to 30 years. Ref. AC28.

Reply Secretary, The British Non-Ferrous Metals Research Association, Euston Street, London, NW1 2EU.

UNIVERSITY OF SOUTHAMPTON

Department of Physics

RESEARCH FELLOWSHIP

Applications are invited for a post-doctoral Research Fellowship in Theoretical Physics for an investigation of critical phenomena. The precise experience of applicants is not crucial but familiarity with Feyman graph methods is essential. The Fellowship is tenable for up to two years from 1 October, 1973 and the initial salary will be on a range up to £2238 (under review). Further particulars may be obtained from Miss J. Hodgson, Department of Physics and applications should be sent to Mr. D. A. S. Copland, Secretary and Registrar's Department, The University, Southampton SO9 5NH to arrive by 30 July, 1973. Please quote ref: NS/292/73/R.

Lecturer Civil Engineering Hydraulics

to lecture in the fields of Hydraulics, Hydrology and Drainage in the 2nd and 3rd years of the Degree Course in Civil Engineering. Excellent facilities exist to carry out own research.

Candidates must have 1st or 2nd class honours degree or equivalent in appropriate subject. Teaching experience would be an advantage.

Salary: Senior Lecturer (£2615–£3640) or Lecturer (£1499–£2177) depending on age, qualifications and experience. Accommodation possibly for a single man. Non-contributory pension scheme. Prospects of promotion.

For further details and an application form (to be returned by 3 August 1973), write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB or telephone BASINGSTOKE 29222, ext. 500 or LONDON 01-839 1992 (24 hour answering service). Please quote S/8312.

Royal Military College of Science
Shrivenham

NATIONAL RESEARCH COUNCIL OF CANADA

requires a

HYDRODYNAMICIST

DUTIES

In the Division of Mechanical Engineering, to carry out hydrodynamic projects associated with ships and marine equipment, with emphasis placed on special problems. This position provides opportunities for original research. Major facilities include complete computer installations, and a cavitation tunnel. Overlap into naval architecture problems is encouraged. Some administrative responsibilities.

QUALIFICATIONS

Post graduate qualifications in Physics or Applied Mathematics; many years of pertinent experience in research & development, including hydrodynamics laboratory work and full scale investigations.

SALARY

Up to $20,021 per annum depending on qualifications and experience.
Apply in writing giving complete details of education and experience to the **Employment Officer, National Research Council of Ottawa, Ontario, KIA 0R6. In reply please quote competition ME-276.**

DEPARTMENT OF BIOCHEMISTRY

QUEEN'S UNIVERSITY BELFAST

Applications are invited from honours graduates in biochemistry or chemistry for

TWO RESEARCH ASSISTANTSHIPS

financed by a grant from the Cancer Research Campaign. The work will involve the isolation of the proteolytic enzymes from malignant cells which are believed to be involved in the invasive process. From a study of the specificities of those enzymes, it is hoped to synthesize highly specific irreversible inhibitors as potential agents to arrest the spread of malignant growths. The appointments are for one year from 1st October 1973 in the first instance, but may be renewed to operate for a total of three years. The salary will be £840 p.a. and the research assistants will be eligible to work for a higher degree.

Applications with the names of two referees should be sent to **Professor D. T. Elmore, Department of Biochemistry, Medical Biology Centre, Queen's University, 97 Liaburn Road, Belfast, BT9 7BL, N. Ireland, by 23rd July, 1973.**

M.R.C. Clinical Research Centre
(Northwick Park Hospital)
Watford Road, Harrow, Middlesex HA1 3UJ

TECHNICIAN/JUNIOR TECHNICIAN

required for the Section of Electron Microscopy to assist in the preparation of specimens for electron microscopy and the processing of electron-micrographs. Applicants should be experienced in this field. Qualifications:—Technician—AIMLT or equivalent. Junior Technician—2 'A' levels in science subjects.

Salary:—Technician—£1461 to £2280 a year. Junior Technician—£957 to £1416 a year.

Application forms may be obtained from Mrs. J. Tuckar-Bull. Please quote ref. 112/2.

ANALYTICAL TECHNICIANS

International company manufacturing dyestuffs and fine chemicals for world wide distribution require two experienced analysts for work in their modern well equipped laboratories at Hounslow, Middlesex, dealing with the analysis of raw materials and high quality colours for use in the food, pharmaceutical and cosmetic industries. An additional function of the department is the provision of an analytical service to R & D and Technical Service units.

Applicants in their twenties with proficiency, or the desire to attain proficiency, in all classical analytical techniques including I.R. and U.V./Visible Spectrophotometry, Atomic Absorption, G.L.C. and Liquid Chromatography should be educated to ONC, HNC, HDN or pass degree standard in Chemistry. Conditions of employment are first class and attractive and regularly reviewed salaries are envisaged. Applicants who see themselves able to make a useful contribution in a progressive and successful analytical team are invited to write, in confidence, with brief details to:- The Personnel Manager, Williams (Hounslow) Limited, Greville House, Hibernia Road, Hounslow, Middlesex.

THE GRASSLAND RESEARCH INSTITUTE

Hurley Nr Maidenhead Berkshire SL6 5LR

ASSISTANT SCIENTIFIC OFFICER required to assist in the research programme of the Soils and Plant Nutrition Department. Work is concerned with the chemistry of plants in relation to the nutritional value of forages for ruminants. It will involve the use of modern instrumental techniques and is essentially research of a non-routine nature.

Applicants should have as minimum qualifications four "O" levels, one of which should be English Language and one a Science. An "A" level in Chemistry would be an advantage. Consideration will be given to applicants awaiting University entrance for appointment to a temporary post.

SALARY: On age scale—£844 (at age 18), £959 (at age 19), £1077 (at age 20), £1397 (at age 25 or over).

APPLICATIONS in writing naming three referees to the PERSONNEL OFFICER by 23rd July 1973. Please quote reference 1/K/18.

ST. GEORGE'S HOSPITAL, S.W.17.

Department of Chemical Pathology

Applications are invited for a BASIC GRADE BIOCHEMIST position in this Department.

The work will be concerned with the further development and assessment of a Fast Chemical Analyser and the modification of current chemical analysers to suit this analyser. Applications by the 27th July to Mrs. Sterling, Department of Chemical Pathology, St. George's Hospital, Blackshaw Road, S.W.17.

MILL HILL SCHOOL, NW7

A vacancy will arise on 1st September 1973 for a Physics Laboratory Assistant. A suitable applicant would also be put in overall charge of the Biology and Chemistry Laboratories (each department has its own laboratory assistant).

Apply to Director of Science.

LONDON BOROUGH OF HOUNSLOW

Education Department

LABORATORY ASSISTANTS, part-time, required from September 1973 at the Heathland School, Wellington Road South, Hounslow, for:—

(a) $31\frac{3}{4}$ hours a week for 40 weeks a year (term-time only) Salary Scale Grade T.1/2 according to age, qualifications, experience and work undertaken, ie, over 21 years of age £816 to £1058.

(b) 19 hours a week for 40 weeks a year (term-time only). Salary scale Grade T.1/2 according to age, qualifications, experience and work undertaken, ie over 21 years of age £488 to £633.

Application forms from Director of Education, 88 Lampton Road, Hounslow, Middlesex, returnable by 27th July 1973. Tel: 01-570 7728 Ext. 537.

THE KENNEDY INSTITUTE

Division of Clinical Research

SENIOR RESEARCH TECHNICIAN required for work on connective tissue disease. Minimum qualification H.N.C. or equivalent. Previous experience of tissue culture or immunological techniques would be an advantage. In addition to participation in research projects, the post carries some administrative responsibilities and offers good career prospects.

Initial salary according to age, experience and qualifications, on Whitley Council scales.

Written applications, giving full details and naming two referess, to the Laboratory Superintendent, Kennedy Institute, Bute Gardens, London W6 7DW.

TECHNICIAN (MALE) required for laboratory preparing from human blood plasma materials for the treatment of patients suffering from bleeding disorders. Qualifications: Minimum HNC or equivalent in Applied Biology (Biochemistry option) or Chemistry, together with several years' appropriate experience. Salary on Scale £1,464-£2,154 p.a. Applicants with suitable academic qualifications but lacking laboratory experience would be considered for appointment in the first instance to the junior technician grade, with prospect of early promotion if proved satisfactory. Write for application form to Secretary, Plasma Fractionation Laboratory, Oxford Haemophilia Centre, Churchill Hospital, Headington, Oxford, OX3 7LJ.

RESEARCH TECHNICIAN (T.G.S., Grade III: Salary range £1539-£1797 per annum) required to assist with research in insect ecology at The Imperial College Field Station, Silwood Park. Field sampling is an important part of the duties. Suitably qualified applicants should write naming two referees by 20 July to The Director, Imperial College Field Station, Silwood Park, Ascot, Berks.

INFORMATION SCIENTIST required to assist with the compilation and editing of a monthly abstracting journal for the printing industry, to undertake literature searches and to answer enquiries. Application forms from The Secretary, PIRA, Randalls Road, Letherhead, Surrey, quoting ref: INF/PR/773.

GRADUATE SCIENTIST required for Electron Microscopy Research in medical unit. Training given. Apply Dr Billing, Royal Free Hospital, Gray's Inn Road, London WC1X 8LF.

WALMSLEYS (BURY) LIMITED
Bolton Works, Crompton Way, Bolton

GRADUATE ENGINEER–

Research & Development

This senior position would be concerned with the development and assessment of performance of various types of forming equipment for the production of paper and board.

This calls for the design of equipment to handle flow of cellulose fibre suspensions by various methods and the applicant should have a specific interest in and knowledge of hydraulics. He should be a graduate engineer with a good mechanical engineering background and preferably have had some industrial experience in the general field of fluid flow, ideally but not essentially in papermaking.

This is a senior appointment for which salary will be negotiable.

Applications should please be made in writing stating age, qualifications and full details of previois experience to the Personnel Manager, Walmsleys (Bury) Limited, Atlas Works, Bury BL8 2QT, Lancs.

THE
WALMSLEY
GROUP OF COMPANIES

1968 1972

Manufacturers of Paper-Making Machinery to the World

THE UNIVERSITY OF MANCHESTER

LECTURER IN GEOLOGY

Applications invited for this post, tenable from October 1st. Candidates should have a special interest in matemorphic petrology. Initial salary within range p.a. £1,764-£2,238 (under review). FSSU. Particulars and application forms (returnable by August 3rd) from the Registrar, The University, Manchester, M13 9PL. Quote ref: 120/73/NS.

G.K. BUREAU specialises in the recruitment of all grades of technicians, medical representativea, editorial assistants, technical translators, information scientists and computer staff in medical industrial and allied fields. Write or phone G.K. Bureau, 17 Shaftesbury Ave. W1 734-7232.

JUNIOR TECHNICIAN TECHNICIAN

with experience in histopathology with HNC or taking HNC. To take part in research work in renal disease. Allowance for day release.

Applications to Professor H. E. de Wardener, Department of Medicine, Charing Cross Hospital Medical School, Fulham Palace Road, London, W6 8RF.

TECHNICIAN required for expanding Clinical Virus Laboratory. A good general experience of relevant diagnostic techniques is desirable. Salary in range £1,473-£1,896 p.a. according to qualificationa and experience. Applications to the Secretary, Royal Postgraduate Medical School, Hammersmith Hospital, Du Cane Road, London W12 0HS, quoting reference: 10/112/NS.

Biochemist

A vacancy exists for a biochemist to work on the chemical modification and support of enzymes. Applications are invited from young graduates or Ph.Ds, who should have a good academic background, which may be in either chemistry of biochemistry, and who consider that they have a special interest in and flair for problems in enzymology.

Beecham Research Laboratories are part of the Beecham Group and this appointment will be taken up at their research station at Walton Oaks, Tadworth, Surrey, which is within easy reach of London. Please reply briefly, stating age, qualifications and experience to:

BRL

Manager, Personnel Department
(Research), Beecham Research
Laboratories, Walton Oaks,
Dorking Road, Tadworth, Surrey.

1972

THE GRASSLAND RESEARCH INSTITUTE

Hurley, Maidenhead, Berkshire

ELECTRON MICROSCOPIST will be required towards the end of the year to work with a small group on the structure of sieve tubes in relation to the mechanism of translocation in plants.

Applicants should have as a minimum qualification HNC or a pass degree in biology/biochemistry/chemistry or physics, and appropriate experience in a biological field.

A current driving licence is essential as the electron microscope is located some distance from the Institute.

Appointment as SCIENTIFIC OFFICER (£1318-£2177 pa) or HIGHER SCIENTIFIC OFFICER (£2076-£2667), the grade and starting salary depending on qualifications and experience. At least five years' relevant post-qualifying experience is normally required for appointment in the higher grade.

Superannuation allowance of $5\frac{1}{2}$ per cent of salary to offset personal contributions to an optional contributory scheme.

Application forms and further details from the Secretary quoting reference 12/G/26 by 31 July 1973.

CITY OF LONDON POLYTECHNIC

RESEARCH APPOINTMENTS IN CHEMISTRY

A number of research appointments in the Department of Chemistry will be available from September, 1973.

Candidates should be qualified to register for a higher degree.

Opportunities exist for research in the following fields:

Chemical Spectroscopy (nmr; IR; Fluorescence)

Synthetic Carbohydrate Chemistry

Electrochemstry

Gas Kinetics

Transition Metal Complexes

Application form and further details from the Secretary, Department of Chemistry, City of London Polytechnic, Sir John Cass School of Science and Technology, 31 Jewry Street, London, EC3N 2EY.

UNIVERSITY OF BRISTOL

RESEARCH UNIT FOR COMPARATIVE ANIMAL RESPIRATION

Technician to assist in Research Council funded work on structure and function of respiratory organs (possibly involving electron microscopy). Salary scale (Grade 3) £1539 × £51 to £1794.

Applications, giving details of qualifications and experience, together with names of two referees, should be sent to Professor G. M. Hughes, Research Unit for Comparative Animal Respiration, The University, Woodland Road, Bristol BS8 1UG, to arrive not later than 7 days after the appearance of this advertisement.

The University of Leeds

Department of Physics

POSTGRADUATE RESEARCH

Applications are invited from graduates with good honours degrees for S. R. C. research studentships in

POLYMER PHYSICS

(Spectroscopy and Mechanical Properties of Solid Polymers)

Enquiries, as soon as possible, to be sent to
Professor I. M. Ward
Department of Physics
University of Leeds
Leeds LS2 9JT

UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Dermatology

JUNIOR RESEARCH ASSOCIATE

Applications are invited from suitably qualified graduates for a post as Junior Research Associate to assist in research into the subcellular localisation of prostaglandin-synthesising enzymes in skin, their role in inflammation, and the effects of anti-inflammatory drugs. Candidates should have a strong biochemical or pharmacological orientation and an interest in enzyme biochemistry. The appointment, which will be available from 1st August, 1973, will be for one year in the first instance, renewable up to a maximum of two years, and is suitable for those wishing to gain a higher degree. Salary on the scale £1,236-£1,476 p.a. (under review).

Applications should be submitted within 14 days of this advertisement to Dr. M. W. Greeves, Department of Dermatology, Royal Victoria Infirmary, Newcastle upon Tyne, NE1 4LP, from whom further details may be obtained if required.

ASSISTANT EDUCATION OFFICER—INSTITUTE OF FUEL

YOUNG GRADUATE

preferably qualified in technology or with training administration experience, required now for new post. His or her work with the Education Officer would include careers advice, short course organization, supervision of small Membership Department (7,000 members) and associated correspondence. Salary around £1,600, somewhat higher for relevant experience. Apply before the 1st August by letter (with c.v.): Education Officer, Institute of Fuel, 18 Devonshire Street, London, W1N 2AU.
(Tel: 01-580-7124).

UNIVERSITY OF READING

Department of Physiology and Biochemistry

Applications are invited from graduates with at least an Upper Second Class honours degree to work for a higher degree on either the metabolic interrelationships between the Caecum and Liver or the sub-unit structure and function of RNA polymerase. Apply to Professor G. M. H. Waites, Department of Physiology and Biochemistry, University of Reading, Whiteknights, Reading RG6 2AH, from whom further information may be obtained by letter or telephone (Reading 85123 ext. 7675). Closing date 24th July 1973. Ref: MS47.

INTERNATIONAL food ingredient manufacturer seeks full technologist or equivalent experienced person in technical servicing or marketing of food ingredients for the position of regional manager of several European countries. Fluency in Slavic or German languages desirable and higher degree in a related discipline. Excellent advancement opportunity with commensurate salary and benefits. Apply in writing c/o Baker & McKenzie (Ref: WJS), Crompton House, Aldwych, London, W.C.2.

THE BRITISH GLASS INDUSTRY RESEARCH ASSOCIATION

SENIOR APPOINTMENTS

THE ASSOCIATION WISHES TO MAKE TWO SENIOR APPOINTMENTS

A new appointment to form and lead a team carrying out work on combustion, furnace operation, glass melting and pollution

The right man will have a good background in high temperature melting and process technology and be able to bring his experience to bear effectively on the technical and environmental problems which the industry experiences in producing glass. Much of the work will involve co-operation in the field with the industrial members of the Association.

To take over and lead work on glass forming processes

The right man will have an adequate knowledge of physics and engineering and with a small but highly experienced team will investigate the problems associated with heat transfer during glass forming. The objectives of this programme are to increase the understanding of glass forming processes and thereby increase their productivity and improve their control. Much of the work will involve co-operation with the industrial members of the Association.

Salaries for these appointments will be within the range £2,750 to £3,500 with membership of the FSSU Scheme.

Applications for these posts, quoting two referees, should be in writing and addressed to:

The Secretary.

The British Glass Industry Research Association
Northumberland Road, Sheffield, S10 2UA.

DIAMOND GRADING

We require a science graduate for work involving the grading of diamonds and precious gemstones, using a variety of analytical methods. An interest in instrumental techniques is more important than background, but this appointment will be of particular interest to a gemmologist, physicist or chemist.

The laboratory is gaining a reputation for objective assessment of precious gemstones and this appointment is being made as a result of expansion.

Salary will be according to experience, 5 day week, non-contributory pension.

Please apply:—

Mr. G. H. T. Mould
Diamond Grading Laboratories Ltd.
46 Hatton Garden
London EC1N 8EX

MICROBIOLOGISTS AT LEATHERHEAD

Microbiologists are required by Beecham Products for their Applied Research and Evaluation Laboratories in the process of establishment at Leatherhead. Initially the successful applicants could be located at Brentford (Proprietary Medicines) or Slough (Foods and Drinks) but would move to Leatherhead within a short period.

The work would be to evaluate Antiseptics and Preservatives in Pharmaceutical Products, to undertake B-vitamin bioassays and examine Foods and Soft Drinks microbiologically.

Training in specialist techniques can be given. The work includes original investigations.

Some of the vacancies are suitable for Graduates or possibly candidates with HND/HNC (Biology) or AIMLT.

There are opportunities also for technicians having 'O' levels as minimum qualifications.

Non-contributory pension and Life Assurance schemes operate.

Applications, quoting age and brief career details, should be sent to:

Personnel Manager,
(Divisional Services),
Beecham Products,
Beecham House,
Great West Road,
Brentford, Middlesex.

POST DOCTORAL RESEARCH FELLOW—STEROIDS

required in Department of Physiology and Biochemistry with experience of techniques in Steroid Radioimmunoassay of body fluids, GLC and TLC and an interest in reproductive biology. This W.H.O. work is part of a programme of study on the Mammalian testis and epididymis. Salary in lower range of Lectureship Scale according to experience and for one year in the first instance. The study is supervised by Professor G. M. H. Waites. Apply in writing, quoting ref. MS45, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, RG6 2AH. Closing date 20th July 1973.

RESEARCH ASSISTANT/TECHNICIAN required by the Department of Clinical Haematology. B.Sc. or equivalent. Whitley Council scales. Please apply to the Secretary, University College Hospital Medical School, University Street, London WC1, quoting reference RA/HAEM.

UNIVERSITY OF NOTTINGHAM

Department of Zoology

Applications are invited for the post of DEMONSTRATOR in the above department. Ample facilities are available for research, particularly in physiological zoology or in cell biology. The successful candidate will be expected to register for the degree of PhD.

The salary scale will be £1278-£1419. Application forms, returnable not later than 23rd July, can be obtained from the Staff Appointments Officer, University of Nottingham, University Park, Nottingham. Quoting Ref. No. 283.

WE NEED A YOUNG AND ENERGETIC WORKER to compile guides on practical Conservation techniques. We will supply some of the know-how (only a little) you will have to find out the rest. Travelling in the U.K. is essential and a car is provided. If you have knowledge of Conservation, Forestry or Agricultural techniques, obviously we shall want to hear from you. Typing an added perk for us! Salary a mere £1400 (max). Apply in writing with two references to British Trust for Conservation Volunteers, Zoological Gardens, Regents Park, London NW1 4RY.

LABORATORY TECHNICIAN required to take charge of Biology Department in Boarding School for boys. Work will include construction of apparatus, preparation and collection of specimens and will require a knowledge of biological techniques. Salary will be on APT scale (Grade I) according to age and qualifications. Accommodation can be made available. Applications with the names of two referees to the Procurator, Ampleforth College, York YO6 4EY. The School is 23 miles north of York in the Helmsley direction.

JUNIOR TECHNICIAN/TECHNICIAN required to work on a project concerning the evaluation of the Makari cancer skin test. Previous experience in this field an advantage but not essential. The project involves collaboration with King's College Hospital and occasional visits there will be required. Salary according to qualifications and experience. Applications to the Secretary, Royal Postgraduate Hostpital, Hammersmith Hospital, Du Cane Road, London W12 0HS, quoting reference 3/328/NS.

The University of Leeds

DEPARTMENT OF ANIMAL PHYSIOLOGY & NUTRITION

Applications are invited for a temporary post of EXPERIMENTAL OFFICER. The appointment will be made for one year in the first instance, with possible renewal for a further two years. Candidates should possess a degree or diploma in agriculture or agricultural science. Salary £1413-£2046 (under review).

Forms of application and further particulars from the Registrar, The University, Leeds LS2 9JT (please quote 418/6/E). Closing date 20 July 1973.

WYTHENSHAWE HOSPITAL MANCHESTER 23.

Applications are invited from Science Graduates for employment in the Pathology Laboratory. The posts are intended for applicants wishing to make a career in Medical Laboratory Technology and excellent facilities and experience are available.

Applications with name of one referee should be sent to the Senior Consultant Pathologist.

AWARDS

MRC

Medical Research Council

Travelling Fellowships 1974-1975

The MRC invites applications from established workers with postgraduate experience in the biomedical field for Travelling Fellowships available for a year from October 1974. The awards may be held at any centre abroad (although certain awards are tenable only in the USA).

The closing date for application is **30 September 1973**.

Application forms and further details may be obtained from:

Medical Research Council, (Grants and Training Awards Section), 20 Park Crescent, London, W1N 4AL.

Telephone: 01-636 5422 (Extensions 240 or 242).

STUDENTSHIPS

LUTON COLLEGE OF TECHNOLOGY

Department of Science

RESEARCH STUDENTSHIP

Applications are invited from Honours Graduates for a Research Studentship to work on aspects of nitrogen fixation in blue-green algae with special reference to their role in temperate agricultural soils.

The post, which is available from 1 September 1973, is for two years with possible extension for a third, and the value of the award is £850 pa. The successful applicant will be required to register for a PhD degree under CNAA regulations.

Applications by letter to **Mr. J. C. E. Howard, Head of Department of Science, Luton College of Technology, Park Square, Luton LU1 3JU.**

UNIVERSITY OF LIVERPOOL

Department of Physics

RESEARCH STUDENTSHIPS

Applications are invited from candidates with a good honours degree for research studentships in the Department of Physics. There are opportunities for research leading to the PhD degree in the fields of Elementary Particle Physics, Nuclear Structure and Solid State Physics.

Enquiries should be sent as soon as possible to the Registrar, The University, PO Box 147, Liverpool L69 3BX. Quote Ref: RV/NS/80357.

SCHOOL OF CHEMISTRY UNIVERSITY OF BRISTOL

Applications are invited from graduates or potential graduates with a good honours degree in chemistry, for a Research Studentship (equivalent to an SRC postgraduate award) funded by Shell Petroleum Ltd. The study, leading to the degree of Ph.D., will be concerned with the fate of isoprenoid biolipids in natural aquatic environments. Techniques used will include radiolabelling methods, capillary gas chromatography, and computerised gas chromatography - mass spectrometry. Applications should be sent to Dr. J. R. Maxwell, Department of Organic Chemistry, University of Bristol, Bristol BS8 1TS.

UNIVERSITY OF ESSEX

Department of Chemistry

RESEARCH STUDENTSHIP

Applications are invited for an S.R.C. POSTGRADUATE STUDENTSHIP for students expecting to graduate with a good Honours degree in 1973.

Applications and requests for further information of fields of research should be sent to: The Chairman, Department of Chemistry, University of Essex, Wivenhoe Park, Colchester, Essex.

TEESSIDE POLYTECHNIC

RESEARCH STUDENTSHIPS IN CHEMICAL ENGINEERING

Applications are invited from graduates or prospective graduates to read for an MPhil or PhD degree concerned with one of the following topics:

(1) Mathematical modelling of a city's microclimate with respect to the dispersal of pollutants.
(2) A kinetic study of the combustion and dispersal of hydrocarbon gases in flare stacks.
(3) Modelling of inhibited industrial fermentation systems involving a multi-stage instrumented, sealed reactor.
(4) Extraction of toxic metals in effluent discharges by electrochemical separation.
(5) The inhibition of metal corrosion in acid-gas scrubbing towers.
(6) An investigation of the microeconomics of a large industrial organisation.

SRC studentships can be offered to suitably qualified candidates and some studentships may be available to candidates not qualified to receive SRC awards.

Applications and enquiries to: Dr. J. R. Walls, Department of Chemical Engineering, Teesside Polytechnic, Teesside TS1 3BA. Telephone 0642 44176.

UNIVERSITY OF LANCASTER

Department of Engineering

RESEARCH STUDENTSHIP IN ELECTRONIC ENGINEERING

Applications are invited from persons interested in undertaking research leading to a Ph.D. degree in Electronic Engineering. The object of the research is to study the characteristics of junction circulators used in microwave communications and radar systems, and the work is expected to be mainly theoretical, requiring a good mathematical background and an interest in computing.

A Science Research Council award is available and is limited to U.K. Science and Engineering graduates with first- or upper-second-class honours degrees, but applications will be considered from students who expect to attain these standards in 1973.

Applications for research on a different topic within the same general field would also be welcomed.

For further particulars and application forms write to:- Dr. C. D. Hannaford, Department of Engineering, University of Lancaster, Bailrigg, LANCASTER, LA1 4YR.

UNIVERSITY OF NOTTINGHAM MEDICAL SCHOOL

Department of Biochemistry

MRC RESEARCH STUDENTSHIP

Applications are invited for an MRC studentship which is available from Ocober 1973. Candidates should hold a good Honours degree in chemistry or a biological science. The successful candidate will pursue a course of research, leading to a PhD degree, involving a study of changes which occur in the protoplast membrane of Bacillus amyloliquefaciens during the secretion of extracellular enzymes with particular regard to the metabolism of membrane phospholipids.

Applications and enquiries should be made to Dr. G. Coleman, Department of Biochemistry, University of Nottingham Medical School, University Park, Nottingham NG7 2RD. Telephone 0602-56101.

IMPERIAL COLLEGE

Applied Optics Section,
Department of Physics

SCIENCE RESEARCH COUNCIL

CASE POSTGRADUATE STUDENTSHIP

Applications are invited for A.S.R.C. Case Studentship for work in collaboration with industry in the development of ultra-fast electron-optical streak cameras for laser pulse measurements. The research student will work for a Ph.D. degree in the laser group of the applied optics section. The work on ultra-fast (picosecond) time measurement techniques plays a key role in the group's research in the study of high power lasers and their interaction with matter, of particular relevance to laser fusion, photochemistry and nonlinear optics. Applicants should have, or expect to obtain this year, at least A11 (1) Honours Degree in Physics, Electronics or related subjects. Applications, with full details of academic career to date, should be sent as soon as possible to:—

Professor D. J. Bradley, Applied Optics Section, Physics Department, Imperial College, Prince Consort Road, London, SW7.

UNIVERSITY OF LIVERPOOL

Department of Oceanography

NERC RESEARCH STUDENTSHIPS IN PHYSICAL OCEANOGRAPHY

Applications are invited for the following Studentships, tenable from 1 October 1973:

(1) Dynamics of estuary and coastal circulation, including the development of a numerical model and related fieldwork;

(2) Oceanic microstructure; an experimental and theoretical approach, including observational work at sea.

Good honours graduates in physics, mathematics, oceanography or a related subject will be considered.

Applications should be sent, as soon as possible, to The Registrar, The University, PO Box 147, Liverpool L69 3BX. Quote Ref: RV/NS/80362.

THE UNIVERSITY OF ASTON IN BIRMINGHAM

Department of Chemistry

RESEARCH STUDENTSHIP

Applications are invited from good honours degree students to undertake research leading to a higher degree. The research is in the field of organosulphur chemistry and will involve synthetic and mechanistic studies on certain new aspects of the subject. The studentship is funded by the S.R.C. Applications including names of two referees should be forwarded to Mr. J. S. Pizey, Department of Chemistry, The University of Aston in Birmingham, Gosta Green, Birmingham B4 7ET.

IMPERIAL COLLEGE

Department of Chemistry

S.R.C. STUDENTSHIP

for study, principally by electron-spin resonance, of impurity centres in metal-oxide semiconductor devices. Applicants (first or upper second class honours graduates with a background in chemistry and physics or semiconductors desirable but not essential), should write to: Dr. J. F. Gibson, Dept. of Chemistry, Imperial College, London SW7 2AY.

UNIVERSITY OF LANCASTER
DEPARTMENT OF PHYSICS
S.R.C. CASE Studentships

Applications are invited from suitably qualified candidates in electronics, materials science or physics for the above studentships to undertake research projects leading to the degree of Ph.D. The projects involve:—

1. Electrical noise in ferroelectrics.
2. Conduction properties of field effect transistors.

The studentships are available for three years.

Places are also available on the one year M.Sc. course in 'Semiconductor Devices' which has been approved by the S.R.C. for the tenure of its advanced course studentships.

For further information contact:—
Administrative Officer, Department of Physics, University of Lancaster, Lancaster, LA1 4YB.

UNIVERSITY OF GLASGOW

RESEARCH STUDENTSHIPS IN CHEMISTRY

Applications are invited from candidates with good honours degrees in chemistry for Research Studentships tenable from 1 October, 1973. Research will be conducted on the following topics in collaboration with various industrial firms: Prostaglandin synthesis (Dr A. J. Baker); New derivatives for the g.l.c. separation of enantiomers (Dr C. J. W. Brooks); β-Lactam antibiotics (Dr E. W. Colvin).

Applications should be addressed to the named supervisors at the Department of Chemistry, University of Glasgow, Glasgow G12 8QQ.

ROYAL HOLLOWAY COLLEGE

(UNIVERSITY OF LONDON)

Egham Hill, Egham, Surrey

Applications are invited for a CAPS Studentship from candidates with a good Honours degree, or the equivalent, in Biochemistry or Chemistry. The successful candidate will join an active research group studying the nature and functions of glycosidasen and will be expected to undertake an investigation of the action of a galactosidases on galactomannans. Applications should be made to Professor J. B. Pridham, (NS) Department of Biochemistry.

UNIVERSITY OF LEICESTER

Department of Astronomy

SRC (CAPS) RESEARCH STUDENTSHIP

Applications are invited from suitably qualified candidates (good Honours degree or equivalent) in mathematics, physics or astronomy for a CAPS award in cooperation with the Meteorological Office. The proposed project involves a theoretical study of the evolution of terrestrial planet atmospheres.

Enquiries should be directed to Professor A. J. Meadows, Department of Astronomy, University of Leicester, Leicester LE1 7RH.

UNIVERSITY OF ST. ANDREWS

S.R.C. CASE STUDENTSHIPS FOR CHEMISTS AND PHYSICISTS IN THE DEPARTMENT OF CHEMISTRY

Applications are invited from those who have Honours Degrees in Chemistry or Physics at the First or Upper Second level, from those with equivalent qualifications, and from those who hope to have such qualifications by October 1973, for the CASE awards listed below. The research will be carried out mainly in the University of St. Andrews and, in part, in the appropriate industrial research laboratory and should lead to a Higher Degree. The studentships carry a maintenance award at the usual S.R.C. level. Candidates should submit details of their academic career along with the names of one or two academic referees to the appropriate academic supervisor at the Department of Chemistry, The University, St. Andrews, Fife KY16 9ST.

(i) Professor F. D. Gunstone (St. Andrews) and Dr. K. Jones (Unilever Research Laboratory, Port Sunlight); Hydroxyalkanesulphonates and Alkenesulphonates.

(ii) Dr. C. A. Vincent (St. Andrews) and Mr. N. F. Jackson (Allen Clark Research Centre, The Plessey Company Ltd. Caswell); Effect of gel structure on ionic conductance and capacitor impedance.

LANCHESTER POLYTECHNIC
Covantry — Rugby

S.R.C. C.A.S.E. Research Studentships

in

Computational Fluid Mechanics
(2 awards, mathematicians or engineers)

Biochemical Pharmacology

Semiconductor Diffusion Measurement

Applicants should possess, or expect to obtain by July 1973, at least an upper second class honours degree or an equivalent qualification. The successful candidates will register for a higher degree.

Application forms and further particulars from the **Assistant Secretary (Personnel), Lanchester Polytechnic Priory Street, Covantry, CV1 5FB,** returnable as soon as possible.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Department of Physics, Applied Optics Section

SRC studentships are available for postgraduate study in Applied Optics.

The MSc course lasts one calendar year (October to September). Applicants should hold or expect to obtain a good honours degree in Physics, Mathematics or Electrical Engineering. SRC studentships are available for suitably qualified students.

Further information and application forms are available from Professor W. T. Welford, Department of Physics, Imperial College, London SW7 2BZ.

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

Engine Research

Applications are invited for an

S.R.C. RESEARCH STUDENTSHIP

tenable for three years in the Department of Mechanical Engineering. Candidates should hold a good honours degree in Enginering or Physics.

Research will be on the application of laser scattering to the measurement of Diesel engine exhaust smoke density, and droplet size distribution in fuel sprays. Successful applicants will be expected to register for a higher degree.

Further details and application forms may be obtained from Dr. J. C. Dent, Department of Mechanical Engineering.

Loughborough **Leicestershire**

UNIVERSITY OF HULL

Department of Chemistry

RESEARCH STUDENTSHIPS

Applications are invited for a postgraduate award for research into the kinetics of free-radical gaseous oxidation reactions, in collaboration with Dr. R. W. Walker and Professor R. R. Baldwin.

Candidates must hold a First or Upper Second Class Honours degree, or equivalent qualification such as G.R.I.C. Part II. Awards are available for three years from September 1st or October 1st, 1973, and are suitable for a Ph.D. candidate. The value of an award is £695 per annum plus fees.

A limited number of awards are also available in the following areas: surface chemistry, the kinetics of unimolecular gas reactions, photochemistry and flash photolysis, heterogeneous catalysis, mechanism of oranic and inorganic reactions in solution, chemistry, of bacterial cell walls, alicyclic chemistry, heterocyclic chemistry, organometallic chemistry in relation to homogeneous catalysis, and transition-metal chemistry.

Interested candidates should write to Professor R. R. Baldwin, Department of Chemistry, The University, Hull, HU6 7RX, specifying the areas of their research interest. The closing date is 20th July, 1973.

INSTITUTE OF PSYCHIATRY

RESEARCH STUDENTSHIP IN NEUROCHEMISTRY

Applications are invited for an MRC Training Scholarship leading to a PhD in Neurochemistry. Upper second or first class degree in Biochemistry or related subject required. The subjects available include the role of cyclic AMP and protein phosphorylation in neural systems or study of neurotransmitters in cultured nerve cells.

Apply as soon as possible to the Secretary, Department of Biochemistry, De Crespigny Park, London, SE5 8AF, or telephone 01-703 5411 quoting reference RR/NS.

BURSARIES

IMPERIAL COLLEGE
LONDON SW7

Applications are invited for

BURSARIES

at rates corresponding to SRC grants, for research into physical studies of combustion systems, including laser diagnostics of flames and of dispersions of droplets. The successful candidates will be eligible to proceed to the DIC and PhD degree.

Applications to Professor F. J. Weinberg, Department of Chemical Engineering & Chemical Technology.

SYMPOSIUM

INTERNATIONAL MICROWAVE POWER INSTITUTE

will sponsor the seventh annual

SYMPOSIUM ON MICROWAVE POWER

10-13 September 1973

Loughborough, England

Subjects include Microwave Power Generation, Microwave Heating Applications, Microwave Instrumentation, Microwaves in the Food Industry, Biomedical Applications and Effects, Economics and Market Research, Equipment Safety.

Further details and information from Mr. H. Barber, Department of Electronic and Electrical Engineering.

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY
LEICESTERSHIRE, ENGLAND

LECTURES, MEETINGS AND COURSES

BRISTOL POLYTECHNIC AND SOUTH WESTERN REGIONAL HOSPITAL BOARD

HIGHER NATIONAL DIPLOMA IN MEDICAL LABORATORY SUBJECTS

Commencing September 1973

This is a three-year, full-time sandwich course offered by the Polytechnic in collaboration with the South Western Regional Hospital Board. The course leads to the Diploma and State Registration as a Medical Laboratory Technician—the prerequisite for a rewarding career in medical laboratory technology.

During the "in service" periods in one of the Pathology Laboratories in Bristol, Bath or Taunton, students will be employed as Junior Laboratory Technicians.

Minimum entry requirements are a General Certificate of Education in four subjects, one having been passed at advanced level and another having been studied to the same standard, one of these two subjects being chemistry.

Further details on the course, career prospects and application forms may be obtained from: Department of Science, Bristol Polytechnic, Ashley Down, Bristol, BS7 9BU, Tel: Bristol 41241.

Polytechnic of the South Bank

MSc Course in Applied Nuclear Physics

This course extends over 12 months full-time or two/three years part-time. It is of modular type and some choice is given between various fields of study.

The complete course consists of lectures and laboratory work plus a five month experimental project. Project work in laboratories outside the College is encouraged. The application of the techniques of nuclear physics to many fields such as solid state and atomic physics, materials analysis and medical physics is emphasized.

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A two/three year part-time course involving attendance for one whole day or three evenings per week. A wide spectrum of fundamental solid state physics is covered but particular stress is laid on the theory and applications of the optical properties of solids.

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Further details of these courses are available from: The Admissions Office (Ref. 904), Polytechnic of the South Bank, Borough Road, London SE1 0AA.
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Ariadne

The affaire Roche has brought home the fact that, in big business, trade marks do matter. The marks Librium and Valium are probably more valuable in the long term, an expert tells me, than ephemeral patent rights on the relevant drugs. Now comes news that the plans laid 10 years ago for a Common Market trade mark scheme have been reactivated. An unofficial translation of the Convention for a European trade mark has just been published (HMSO 47p) and now that the Common Market is a reality, some standardisation over trade mark law is urgently needed. Present EEC philosophy seems to be that what can be lawfully sold in one member country, can be lawfully sold in them all. Thus to have any protection at all, a manufacturer probably needs to register his mark in every EEC country. But the different standards of registerability in the different European countries makes this exceedingly difficult—as well as very expensive. So obviously some form of rationalised single Common Market registration makes sense. The language problems, however, will take a bit of solving. You're all right with Latin for the pharmaceuticals, but the televised efforts to instruct customers how to ask for Cockburns or Noilly Prat show that pronunciation can be an uphill job.

■

Talking of language difficulties, the New England Journal of Medicine (vol 288, p 1399) describes the dilemma of a Belgian doctor invited to a British meeting who was rung up by a Flemish-speaking civil servant suggesting that this should be the language of his address. The call was followed by another. This time it was a French-speaking civil servant putting the case for his language. According to the journal, the Belgian replied that since Britain was now a member of the Community he intended to give his paper in Common Markische, "a language, he explained, with a grammar partly German and partly English, spoken with the musical accent of the Italians, and illustrated with the gestures of the French". Light relief perhaps but I should not be surprised to learn that somewhere in that Brussels building a committee of philologists is hard at work on this very project so that one day Europe's children will be compelled to learn the stuff as a second language.

■

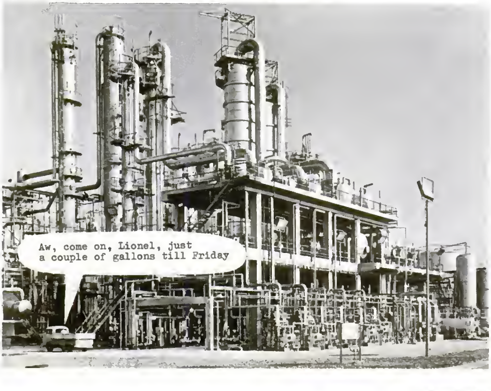
I've been following with interest the row over the hail suppression plan in the San Luis Valley of Southern Colorado (see Feedback, 22 March, p 674). Briefly a brewery company laid on the seeding programme to help growers of Moravian barley used in the manufacture of beer. But the valley folk included ranchers who didn't mind the hail so much but resented what they believed to be a man-made drought. The affair growled along for several years culminating in a referendum last November when 10 281 came down against weather modification against 2553 who supported it. Since then the whole matter has been thrashed out at a public inquiry and now according to Science (vol 180, p 1347) it begins to look as if the federal authorities will introduce comprehensive legislation following Colorado's new state law requiring the intending weather modifier to show that his plan "involves no high risk of harming people, property or the general environment". As I see it, the political consequences of weather modifications are only beginning to be appreciated. For instance, those Israeli scientists recently reported as being well content with their rainmaking over Jordan must surely have taken into account the effect such an announcement must have had on the Arab countries around them. The fellah may not be prepared to give time to study a learned paper on the success of the experiment. He will assume, I am afraid, that someone has robbed him of water.

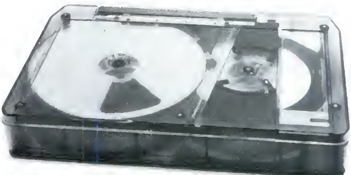
■

It is not only the human mind which technology strives to imitate. Indeed, it is not far behind some of our most ordinary attributes. But what enterprising purveyor of that mundane commodity "rubber goods", I wonder, finally driven to the spectre of bankruptcy by the Pill, had the foresight to clamber aboard the great technological bandwagon? But there it all is—an ad in the CERN Courier: "Technical Rubber and Plastic Goods". Voyeuristic fantasy? Not quite. For underscoring the hoses and dielectric materials, in bold type, is surely the hallmark: "We have special radiation resistant rubber compounds that give unique service . . .". Oh, technoperversion!

■

My cryomotive friend Daedalus is intrigued by the proposal to tow huge tabular icebergs from the Antarctic to Australia to be melted for irrigation purposes. American thinking on this topic favours huge and possibly nuclear-powered tugs to tow the icebergs; Daedalus now proposes to make them propel themselves, for free. He points out that the temperature difference between the ice and the surrounding ocean could in principle power engines. For such a small difference the theoretical maximum efficiency is only about 4 per cent; even so a ton of ice melting a second could give 12 MW of power. An iceberg 10 km x 2·5 km x 250 m might need 500 MW to propel it, requiring a melt-rate of 40 tons/s; but this corresponds to a shrinkage of only 0·001 mm/s all over the submerged surface, about the natural melt-rate. (At this rate the berg would last some five years.) At first Daedalus thought of developing the power by studding the berg with thermocouples to drive electric motors, but he soon dreamt up a more elegant scheme. Fresh water from the melting ice is lighter than the salty ocean water and wells up round the berg. By shaping the stern into a channelled wedge-shape sloping upwards, local melt-water would rise up the slope and flow out the back, creating thrust by its backwash. As the berg began to move, all the melt-water would be entrained towards the stern, augmenting the effect. DREADCO hydrodynamicists are therefore studying the theoretical attrition-regimes of icebergs melt-propelled in warm salty water, to discover the optimum initial stern contour, whether mid-course reshaping will be needed, and whether a rudder or some differential melting system would provide the better steering. This appealing scheme opens up a new field of marine transport. A big berg lasting only five years, but expendable, unsinkable, free and fuel-free, and capable of carrying 10 million tons of cargo, might well be competitive with an expensive freighter of 1 per cent the capacity but lasting 20 years. Bergs may come to dominate the bulk carrier trade, though with considerable impact on the marine collision problem and much heart-searching at Lloyd's.





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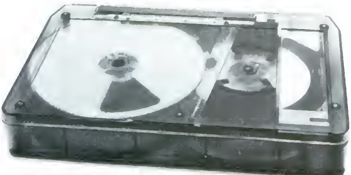

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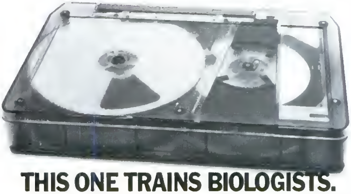

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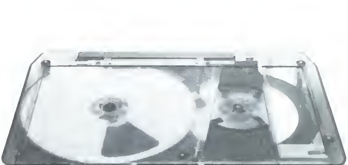

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